Integrated Natural Resources Management Plan

2006 through 2010

Draft Final

III Corps and Fort Hood, TX • February 2006

INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN

FORT HOOD, TEXAS

This Integrated Natural Resources Management Plan has been developed by the III Corps and Fort Hood in cooperation with the United States Department of the Interior, Fish and Wildlife Service, and the Texas Parks and Wildlife Department. The signatures below indicate the mutual agreement of the parties concerning the conservation, protection and management of fish and wildlife resources as presented in the Plan.

PLAN APPROVAL

Victoria Bruzese
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Garrison Commander
III Corps and Fort Hood
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Date

AGENCY AGREEMENT

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PURPOSE

The purposes of this Integrated Natural Resources Management Plan (INRMP) are to guide the natural resources management program at Fort Hood, Texas, from 2006 through 2010 and to provide a solid foundation on which to build the program beyond the year 2010. This INRMP will allow Fort Hood to achieve its goal to ensure the sustainability of desired military training area conditions while maintaining ecosystem viability. In addition, this INRMP will ensure that natural resource conservation measures and Army activities on Fort Hood land are integrated and consistent with federal stewardship requirements.

This plan also contains the associated documentation required for compliance with the National Environmental Policy Act (NEPA), which requires federal agencies to consider the environmental consequences of major proposed actions. The NEPA documentation is in the form of an Environmental Assessment (EA), which analyzes the potential consequences of the proposed action to implement the Fort Hood INRMP.

ENVIRONMENTAL COMPLIANCE

Under the Natural Resource Management on Military Lands Act of 1960 (Title 16 of the *United States Code* [U.S.C.] Sections 670a *et seq.*), commonly known as the Sikes Act, as amended by the Sikes Act Improvement Act of 1997,

> The Secretary of Defense shall carry out a program to provide for the conservation and rehabilitation of natural resources on military installations. To facilitate the program, the Secretary of each military department shall prepare and implement an integrated natural resources management plan for each military installation in the United States under the jurisdiction of the Secretary. Consistent with the use of military installations to ensure the preparedness of the Armed Forces, the Secretaries of the military departments shall carry out the program to provide for the conservation and rehabilitation of natural resources on military installations; the sustainable multipurpose use of the resources, which shall include hunting, fishing, trapping, and nonconsumptive uses; and subject to safety requirements and military security, public access to military installations to facilitate the use.

Per 16 U.S.C. § 670a(b) of the Sikes Act Improvement Act of 1997, to the extent appropriate and applicable, this INRMP provides for the following:

- Fish and wildlife management, land management, forest management, and fish- and wildlife-oriented recreation
- Fish and wildlife habitat enhancement or modifications
- Wetland protection, enhancement, and restoration (where necessary) for the support of fish, wildlife, or plants
- Integration of, and consistency among, the various activities conducted under the plan
- Establishment of specific natural resource management goals and objectives and time frames for the proposed action
- Sustainable use by the public of natural resources to the extent that the use is not inconsistent with the needs of fish and wildlife resources
- Public access to the military installation that is necessary or appropriate for the use described above, subject to the requirements necessary to ensure safety and military security
- Enforcement of applicable natural resource laws (including regulations)
- No net loss in the capability of military installation lands to support the military mission of the installation
- Such other activities as the Secretary of the Army determines appropriate

In preparing this INRMP, Fort Hood has maintained its commitment to ensure that environmental considerations are integral to the mission and has complied with Army Regulation 200-1, *Environmental Sustainability and Stewardship*; the Department of the Army's INRMP Policy Memorandum (21 March 1997), titled *Army Goals and Implementing Guidance for Natural Resources Planning Level Surveys (PLS) and Integrated Natural Resources Management Plan (INRMP)*; and Title 32 of the *Code of Federal Regulations*, Part 651, *Environmental Analysis of Army Actions*. In addition, this INRMP provides the guidance necessary for Fort Hood to maintain compliance with the Endangered Species Act, the Clean Water Act, and Executive Order 11990 (Protection of Wetlands).

SCOPE

This EA identifies, documents, and evaluates the effects of implementing the INRMP for Fort Hood. The INRMP addresses the geographic area associated with the contiguous properties of Fort Hood, with particular emphasis on the training areas. The INRMP portion of the document provides management measures that have been developed by considering various alternatives for meeting resource-specific goals and objectives at Fort Hood. The INRMP also provides the rationale for why certain management measures have been selected for implementation and others have not, based on analysis of resource-specific screening criteria. The EA portion of the document carries the INRMP's selected management measures forward as the proposed action. Some management alternatives were considered and dismissed from further consideration in developing the INRMP; therefore, the EA addresses only the proposed action and a no action alternative.

SUSTAINABILITY AND THE MILITARY MISSION

Fort Hood has developed Desired Future Conditions of the installation to provide the conditions necessary to meet the expected increase in training, ensure the long-term sustainability of the training lands, and provide protection for sensitive and federally protected species. The implementation of this INRMP is expected to maintain the ecological integrity of the landscape and ensure that there is no net loss in the capability of Fort Hood training lands to support the military mission. In addition, the implementation of this INRMP will allow Fort Hood to continue to promote compatible multiple uses of its training lands, such as grazing, hunting, fishing, and other outdoor recreational pursuits to occur in conjunction with military training.

HIGH-PRIORITY PROJECTS

The projects in this INRMP have been screened, and only the high-priority projects have been included in this section. The prioritization of the projects is based on need, and need is based on a project's importance in moving the natural resources management program closer to successfully achieving its goal. Projects will be conducted subject to the availability of funding. The high-priority projects identified by the NRMB, in alphabetical order, are as follows:

- Brown-headed cowbird control
- Cave monitoring
- Cave survey, mapping, and inventory
- Caves and cave fauna
- Construct off-site wetland mitigation bank
- Construction and maintenance of fire breaks
- Ecosystem plantings
- Erosion control and revegetation of watersheds
- Fire damage abatement projects

- Fisheries management
- Habitat delineation
- Implementation of karst management plan
- Juniper management
- Lake and pond management
- Oak wilt management in endangered species habitat
- Planning Level Surveys
- Predator control
- Predator population management
- Prescribed burning for ecosystem management
- Protection of T&E species: golden-cheeked warblers
- Protection of T&E species: black-capped vireos
- Repair of eroded and damaged trails
- Stream water sampling stations and mitigation
- Survey of endemic cave salamander
- Survey of Texas horned lizard
- Training lands management plan
- Vegetation monitoring of fire effects in endangered species habitat
- Wetland survey
- Wildlife management

ENVIRONMENTAL CONSEQUENCES

The EA findings, summarized in Table ES-1, are consistent with the goals of the natural resources management program to ensure the long-term sustainability of desired military training area conditions; to maintain, protect, and improve ecological integrity; to protect and enhance biological communities, particularly sensitive, rare, threatened, and endangered species; to protect the ecosystems and their components from unacceptable damage or degradation; and to identify and restore degraded habitats. The preferred alternative, implementation of the INRMP, would directly and positively affect the health and condition of natural resources at Fort Hood. No significant cumulative effects would be expected. Because no significant environmental impacts would result from implementation of the proposed action, preparation of an Environmental Impact Statement is not required and preparation of a Finding of No Significant Impact is appropriate.

Table ES-1
Summary of Potential Environmental Consequences

Resource Area/Environmental Condition	Environmental Consequences	
	No Action	**Proposed Action**
Land Use	Moderate adverse effects	Beneficial effects
Soils	Moderate adverse effects	Beneficial effects
Water Resources	Moderate adverse effects	Beneficial effects
Wetlands	Moderate adverse effects	Beneficial effects
Aquatic Habitat	Moderate adverse effects	Beneficial effects
Terrestrial Habitat	Moderate adverse effects	Beneficial effects
Fish and Wildlife	No effects	Beneficial effects
Endangered, Threatened, and Rare Species	No effects	Beneficial effects
Cultural Resources	Minor adverse effects	Beneficial effects
Facilities	No effects	No effects
Air Quality	No effects	No effects
Noise	No effects	No effects
Hazardous and Toxic Materials	No effects	No effects
Socioeconomic Resources	No effects	No effects
Environmental Justice	No effects	No effects
Cumulative Effects	Adverse effects	Beneficial effects

SECTION 1.0: OVERVIEW

> *The Army is committed to environmental stewardship in all actions as an integral part of its mission and to ensure sustainability.*
>
> *(Army Regulation 200-1, Environmental Sustainability and Stewardship, 2004)*

The purposes of this Integrated Natural Resources Management Plan (INRMP) are to guide the natural resources management program at Fort Hood, Texas, from 2006 through 2010 and to provide a solid foundation on which to build the program beyond the year 2010. This INRMP will allow Fort Hood to achieve its goal to ensure the sustainability of desired military training area conditions while maintaining ecosystem viability. In addition, this INRMP will ensure that natural resource conservation measures and Army activities on Fort Hood land are integrated and are consistent with federal stewardship requirements.

1.1 INRMP VISION

Under the Natural Resource Management on Military Lands Act of 1960 (Title 16 of the *United States Code* [U.S.C.] Sections 670a *et seq.*), commonly known as the Sikes Act, as amended according to the Sikes Act Improvement Act of 1997,

> The Secretary of Defense shall carry out a program to provide for the conservation and rehabilitation of natural resources on military installations. To facilitate the program, the Secretary of each military department shall prepare and implement an integrated natural resources management plan for each military installation in the United States under the jurisdiction of the Secretary. Consistent with the use of military installations to ensure the preparedness of the Armed Forces, the Secretaries of the military departments shall carry out the program to provide for the conservation and rehabilitation of natural resources on military installations; the sustainable multipurpose use of the resources, which shall include hunting, fishing, trapping, and nonconsumptive uses; and subject to safety requirements and military security, public access to military installations to facilitate the use.

Per 16 U.S.C. ' 670a(b) of the Sikes Act Improvement Act of 1997, to the extent appropriate and applicable, this INRMP provides for the following:

- Fish and wildlife management, land management, forest management, and fish- and wildlife-oriented recreation
- Fish and wildlife habitat enhancement or modifications
- Wetland protection, enhancement, and restoration (where necessary) for the support of fish, wildlife, or plants
- Integration of, and consistency among, the various activities conducted under the plan
- Establishment of specific natural resource management goals and objectives and time frames for proposed action
- Sustainable use by the public of natural resources to the extent that the use is not inconsistent with the needs of fish and wildlife resources, or mission requirements
- Public access to the military installation that is necessary or appropriate for the use described above, subject to the requirements necessary to ensure safety and military security
- Enforcement of applicable natural resource laws (including regulations)
- No net loss in the capability of military installation lands to support the military mission of the installation and
- Such other activities as the Secretary of the Army determines appropriate

The Army's commitment to the conservation of its natural resources is further reflected in Army Regulation (AR) 200-1, *Environmental Sustainability and Stewardship* (1 August 2004) and Headquarters, Department of the Army's (HQDA's) INRMP Policy Memorandum (21 March 1997), titled *Army Goals and Implementing Guidance for Natural Resources Planning Level Surveys (PLS) and Integrated Natural Resources Management Plan (INRMP)*. Two of the major program goals of AR 200-1 are to "integrate environmental stewardship and compliance responsibilities with operational requirements to help achieve sustainable ranges and training areas" and to "develop, initiate, and maintain forward-looking programs for the conservation, utilization, and rehabilitation of natural resources on Army lands" (HQDA, 2004). The INRMP Policy Memorandum states that the purpose of completing the INRMP is "to ensure that natural resource conservation measures and Army activities on mission lands are integrated and are consistent with federal stewardship requirements" (HQDA, 1997).

Title 32 of the *Code of Federal Regulations* (CFR) Part 651, Environmental Analysis of Army Actions, "sets forth policy, responsibilities, and procedures for integrating environmental considerations into Army planning and decision making" (67 FR 15290, March 29, 2002). In particular, 32 CFR 651.12, Integration with Army Planning, states that "The Army goal to integrate environmental reviews concurrently with other Army planning and decisionmaking actions avoids delays in mission accomplishments. To achieve this goal, proponents should provide complete environmental documents for early inclusion with any recommendation or report to decisionmakers (Master Plan, Natural Resources Management Plan, Remedial Investigation, FS [Feasibility Study], etc.). The same documents will be forwarded to planners, designers, and/or implementers so that recommendations and mitigations on which the decision was based may be carried out."

This document reflects Fort Hood's commitment to conserve, protect, and enhance the natural resources necessary to provide realistic military training for soldiers.

1.2 STRATEGIC GOALS AND OBJECTIVES

The strategic goal of this INRMP for Fort Hood conforms to the goal of the Conservation Program of the Department of Defense (DoD), which is to support the military mission by

- Providing for sustained use of its land and air resources
- Protecting valuable natural and cultural resources for future generations
- Meeting all legal requirements
- Promoting compatible multiple uses of those resources
- Achieving efficiencies and other savings by partnering with interested stakeholders

Fort Hood's Natural Resources Management Branch (NRMB) has identified a number of objectives necessary to achieve this goal:

- Manage all resources to support long-term sustainment of the installation's training mission.
- Implement a natural resources management program that reflects the principles of ecosystem management.
- Provide special protection and management that lead to the recovery of threatened and endangered species and protect species of special concern.

- Manage wildlife and fisheries resources within the principles and guidelines of ecosystem management to maintain productive habitats and viable populations of native species.
- Provide outdoor recreational opportunities to the extent that they do not conflict with the military mission.
- Use adaptive management techniques to provide the flexibility to adapt management strategies based on increased knowledge and data gained from monitoring programs and scientific literature.
- Seek to maintain or increase the level of biodiversity of native species.
- Protect forest resources from unacceptable damage and degradation resulting from insects and disease, animal damage, invasive species, and wildfire; and manage the resources in a manner that supports the military mission.
- Prevent the degradation of water quality, protect aquatic and riparian habitats, and identify and restore degraded habitats.
- Protect soil resources from erosion and destabilization through prevention and restoration efforts.
- Protect and preserve cultural resources.
- Protect rare and unique plant species identified as state or locally rare, but without legal protection status, to the extent practical without restrictions on operations.
- Protect sensitive and ecologically significant habitats located on Fort Hood.
- Provide a positive contribution to the community by offering informative and educational instruction and opportunities.

The primary goals of the natural resources management program, as established by Fort Hood and described above and in detail in Section 3.0, are to maintain ecosystem viability and ensure the sustainability of desired military training area conditions; to maintain, protect, and improve ecological integrity; to protect and enhance biological communities, particularly sensitive, rare, threatened, and endangered species; to protect the ecosystems and their components from unacceptable damage or degradation; and to identify and restore degraded habitats.

The ability to achieve these goals depends directly on the health and condition of the natural resources. The success of the military mission at Fort Hood depends on the condition of the natural resources as well. Protecting the ecological and biological integrity of the training lands ensures that those lands will continue to provide the vegetation, soil, and water resources necessary for realistic military training. Such protection will also preserve popular outdoor recreational activities at Fort Hood, such as hunting, fishing, birding, swimming, boating, and hiking. Implementing ecosystem management principles will provide the quantity and diversity of fish and game for enjoyable hunting and fishing experiences. Proper management of the terrestrial ecosystems will maintain the water quality at a level that can support fisheries and presents no potential risks to human health from swimming or boating.

To protect cultural resources, the military trainers and the natural resources staff will maintain adequate communication with the cultural resources staff. All activities on the reservation having the potential to affect cultural resources will be coordinated with the cultural resources staff.

The natural resources management program must remain flexible if it is to achieve long-term success. The program will achieve and maintain this flexibility by incorporating adaptive management techniques. Adaptive management is a process by which new information from monitoring data, scientific literature, or both is used to evaluate the success of the management measures currently in place. This information is then used to determine changes in the management approach needed to ensure continued success of the program. The natural resources management program might also be required to adapt to unforeseen changes in military mission and legal requirements.

Maintaining optimal environmental conditions on training lands is essential for the success of the military mission at Fort Hood. Therefore, the focus of this INRMP is on management of natural resources in the training areas. Management measures have been developed based on current conditions of the resources, and the military mission and activities as they are anticipated.

1.3 RESPONSIBILITIES AND INTERESTED PARTIES

The success of the management of natural resources on Fort Hood and the implementation of this INRMP requires a cooperative effort among the parties directly responsible. The level of success can be enhanced by Fort Hood's forming partnerships with other parties that have a vested interest in the responsible management of the natural resources at the installation. A brief description of the parties directly responsible for the implementation of this INRMP, as well as other interested parties, is provided below.

1.3.1 Fort Hood

The roles of the organizations at Fort Hood that are directly responsible for, or are providing assistance in, the implementation of this INRMP are described below.

Commanding General. The Commanding General has the overall responsibility for the implementation of the INRMP, including sustaining readiness training and complying with all laws and regulations associated with the protection of the installation's natural resources.

Garrison Commander. The Garrison Commander conducts base operations in support of Fort Hood and tenant activities, including the preparation and implementation of an INRMP for the installation.

Directorate of Public Works (DPW). DPW plans, directs, and schedules maintenance, repair, alteration, modification, construction, and operation of physical plant facilities and engineer equipment to perform the Fort Hood mission for interim, peacetime, and mobilization operations. DPW develops coordinated master plans for future development and allied construction programs. It ensures that construction projects proposed for completion by troop units agree with the Fort Hood master plan and DA directives. As the environmental and energy control engineers, DPW's staff members direct and coordinate utilities conservation and environmental programs. DPW serves as the fire marshal, providing fire prevention and protection for the installation. DPW also conducts high-visibility and command-interest special studies to evaluate the effectiveness of current and projected operations. Finally, DPW manages and maintains family housing operations for the installation.

Environmental Division (ENV). ENV is responsible for the conservation, restoration, protection, and enhancement of the environment at Fort Hood. This includes the management and oversight of the natural resources (land, fish and wildlife), water pollution abatement, pest management, cultural resources, recycling, hazardous waste management, and energy programs.

Environmental Management Branch. The Environmental Management Branch manages, coordinates, and monitors environmental programs; develops, prepares, and monitors long-range plans for environmental resources; operates the DPW Classification Unit for processing, packaging, and labeling of hazardous waste generated on the installation; requests and maintains state and federal operating permits or exemptions for solid waste, hazardous waste, air discharges, water, and wastewater; develops and administers the spill contingency plan; coordinates, prepares, reviews, and updates environmental impact statements (EISs), environmental assessments (EAs), and records of environmental consideration; prepares and reviews plans for service projects and in-house projects for pollution prevention measures; prepares A-106 reports to support environmental program funding; provides professional engineering expertise in developing projects and guiding engineer design for areas that affect environmental functions; provides technical training on environmental matters to civilian activities and troop units; and provides technical oversight for environmental restoration projects.

Natural Resources Management Branch (NRMB). ENV's NRMB manages, coordinates, and monitors natural resources, fish and wildlife, land, and pest management. It also protects and improves fish and wildlife habitats; establishes and recommends protective measures and practices in construction and maintenance activities to avoid pollution, burning, and unnecessary destruction of habitat; monitors, investigates, and recommends management and procedures related to game animals, birds, and fish; surveys and recommends improvements for food, cover, and water sources for wildlife; develops and monitors fish and wildlife inventories and population indices; maintains liaison with state land grant colleges and other local, state, and federal wildlife management agencies; recommends, implements, and inspects fish and wildlife development projects through unimproved grounds section and rehabilitation contracts; prepares reports, interagency agreements, and long-range plans related to program development and future planning; coordinates with the Directorate of Community Activities, Community Recreation Division, and other elements to ensure safe and efficient conduct of hunting and fishing activities; collects and analyzes biological data during annual deer and turkey harvests; manages the funds and budget for fish and wildlife activities; performs the function of staff agronomist and entomologist; develops, prepares, and monitors long-range plans for the use and improvement of natural resources programs; develops, manages, and coordinates agricultural out-lease programs and pest management plans; prepares and reviews plans for service projects and in-house landscape, natural resources, and pest control projects; operates a geographic information system for the collection and analysis of automated natural resource databases; and coordinates the clearance of machine-assisted excavation in unimproved grounds.

Directorate of Plans, Training, and Security (DPTS). DPTS, particularly the Range Division, is the link between troops training in the field and natural resource management. DPTS is responsible for the scheduling of training lands and range complexes and for training land management and repair, administering the Integrated Training Area Management (ITAM) program in close coordination with the NRMB. DPTS also provides awareness training to the troops on the importance of the controlled use and protection of the installation's natural resources.

Directorate of Community Activities (DCA). DCA plans and promotes the development of recreational facilities such as boat docks, camping areas, and picnic areas. DCA is responsible for administration of the outdoor recreation program, including the sale of hunting and fishing permits and licenses through the Sportsmen's Center, and the guided hunt program.

Provost Marshal Office (PMO). The PMO provides natural resources law enforcement on the installation, including enforcement of hunting, fishing, archaeological, and environmental statutes and regulations. The PMO has partial responsibility for conducting domestic animal control. The PMO documents reports of endangered species habitat violations and works with NRMB to ensure compliance with wildlife harvest quotas, disposes of dead wildlife resulting from motor vehicle operations, and provides a portion of the training required for hunter safety certification.

1.3.2 Other Defense Organizations

U.S. Army Corps of Engineers (USACE), Fort Worth District. The Fort Worth District is providing contractor support for the preparation of this INRMP and EA for Fort Hood. The Fort Worth District also has responsibility for military construction on Fort Hood, and for permitting and administering wetland permits in accordance with Section 404 of the Clean Water Act. In addition, the District assists Fort Hood with the administration of a livestock grazing lease, as well as other natural resource management needs.

U.S. Army Corps of Engineers Environmental Research Laboratory (CERL). Tim Hayden of USA-CERL collaborates with a number of universities for research studies at Fort Hood. Details are provided below under Section 1.3.5, Universities.

U.S. Army Environmental Center (USAEC). USAEC is a field operating agency under the Assistant Chief of Staff (Installation Management), Department of the Army. USAEC is responsible for providing support for conservation programs to Army installations.

1.3.3 Other Federal Agencies

A number of federal agencies, in addition to DoD and Fort Hood, have an interest or a role in the management of natural resources at Fort Hood. The involvement of these agencies is based on signatory responsibilities, cooperative agreements, regulatory authority, and technical assistance as required by federal laws and regulations. The agencies and their roles and responsibilities are described below.

U.S. Department of the Interior (DOI), U.S. Fish and Wildlife Service (USFWS). USFWS provides signatory approval of the fish and wildlife aspects of the INRMP. It is the primary federal agency for issues regarding fish and wildlife management, as well as the regulatory authority for the Endangered Species Act (ESA) of 1973 and the Migratory Bird Treaty Act (16 U.S.C. §§703–711). USFWS provides oversight and assistance with management of the black-capped vireo and golden-cheeked warbler.

U.S. Department of Agriculture (USDA), Natural Resources Conservation Service (NRCS). NRCS provides technical assistance through a Memorandum of Understanding (MOU). NRCS assists in the Range and Training Land Analysis (RTLA) and Land Rehabilitation and Maintenance (LRAM) programs, updates the soils survey, inventories the condition of the training areas, identifies erosion-damaged areas, and develops best management practices (BMPs) and management measures to minimize and control erosion and repair degraded areas. NRCS also performs much of the necessary range rehabilitation work, including the construction of gully plugs, ripping of compacted soils, and reseeding. The ITAM program and the NRCS collaborate on the work to be performed and the funding. NRCS is also involved in some placement of dairy compost on training lands as a means of adding nutrients and organic matter back into the soils.

USDA, Blackland Research Center. The Blackland Research Center conducts stream monitoring for suspended solids and flow rates during flood events at a number of sampling locations on the installation.

USDA, Forest Service. The Forest Service provides funding and support for oak wilt treatment. In fiscal year (FY) 2005, the Forest Service provided Fort Hood with $100,000 to do some trenching and deep girdling of symptomatic trees. Fort Hood has requested a similar amount for FY 2006.

1.3.4 State Agencies

Texas Parks and Wildlife Department (TPWD). TPWD provides signatory approval of the fish and wildlife aspects of the INRMP, and it is the primary state agency for issues regarding fish and wildlife management at Fort Hood.

1.3.5 Universities

Several universities are active participants in projects at Fort Hood. An overview of this research is provided below.

The University of Illinois (U of I) collaborates with USA-CERL on a number of projects at Fort Hood. Current investigations include a radiotelemetric study of the rat snake (a major nest predator) and research on a new species of Plethodontid salamander.

Cornell University has been developing some bioacoustics survey technology to detect birds in inaccessible areas, such as the live-fire impact area. This research is expected to be expanded in 2006 to begin the development of a "soundscape" for Fort Hood, with a focus on birds of conservation concern as identified on Partners in Flight lists.

In addition, Tim Hayden at USA-CERL will continue some radiotelemetric work over the next 3 years to monitor birds' physiological responses to military training. His project involves collaborators from Princeton, Tufts University, and U of I. Mr. Hayden is also collaborating with Dr. Richard Lance at Louisiana State University on a range-wide genetics study of black-capped vireos and golden-cheeked warblers. Fort Hood, through USA-CERL, also has a cooperative project with the U.S. Environmental Protection Agency's (USEPA's) Pacific Northwest National Laboratory, which is researching potential repellants for fire ants as well as environmentally benign fire ant mound treatment techniques.

In recent years, Fort Hood has sponsored graduate projects at the University of Oklahoma, University of Vermont, and University of Missouri.

Fort Hood also informally consults with Texas A&M University on finding and mapping oak wilt centers and advice on treatment. The treatments are applied by either personnel from The Nature Conservancy (TNC) or contractors. TAMU conducts an annual forage inventory to provide information necessary for determining grazing allotments.

The University of Texas provides expertise to Fort Hood for karst invertebrate taxonomy.

1.3.6 Contractors

Contractors provide DPW with technical support for natural resources and environmental management projects. This technical support includes preparation of the INRMP, National Environmental Policy Act (NEPA) analyses and documentation, cultural and biological resource surveys, and general natural resources support.

1.3.7 Other Interested Parties

Fort Hood's natural resources management strategy includes partnerships and cooperative projects with natural resource agencies, universities, and private organizations. These partnerships bring essential resources and additional expertise to the management of Fort Hood's natural resources and have helped to establish favorable public opinion of the natural resources management program.

The Nature Conservancy (TNC). TNC has been providing support to Fort Hood's endangered species management program since 1993 through cooperative agreements. The cooperative agreement provides a mechanism for transfer of funds to TNC for implementing tasks required under the terms and conditions of the Biological Opinion agreement with the USFWS. The nature of the cooperative agreement is ideally suited for cutting-edge scientific research because it encourages synergism through the combination of diverse backgrounds and expertise and leverages the assets of both organizations toward the achievement of mutual goals. The flexibility provided by the agreement allows for the application of dynamic processes driven by the data, rather than dictated by contract terms. The nonprofit status of TNC reduces administrative costs, providing an excellent value to the Army, and the cost-reimbursement basis for payment adds flexibility by allowing for minor refinements in project scopes and requirements within the general budget framework. TNC is providing support to Fort Hood in the following areas:

- Black-capped vireo research and monitoring
- Golden-cheeked warbler research and monitoring
- Brown-headed cowbird management and research
- Vegetation ecology research and management
- Mapping and remote sensing
- Prescribed fire and habitat management
- Karst management and survey
- Off-post habitat protection

More detailed information on these projects and work areas will be provided in Sections 2.0 and 3.0.

Cooperation with Other Agencies. At the request of the USFWS, the Fort Hood Endangered Species Management Program serves as the coordinator for all color-banding efforts across the ranges of both the black-capped vireo and the golden-cheeked warbler. This occurred because the volume of banding data produced by the Fort Hood effort vastly exceeded that from the combined efforts of all other banders, and because Fort Hood personnel had developed a computer program to generate all possible color combinations with a designated number of colors. Fort Hood serves as the issue point and clearinghouse for all color-banding data and maintains a cooperative relationship with the Balcones Canyonlands National Wildlife Refuge, the Texas Department of Transportation, and the Texas Parks and Wildlife Department, along with a number of private consulting agencies. In addition, Fort Hood personnel served on the Biological Advisory Team during the development of the Austin Regional Habitat Conservation Plan and currently hold advisory positions on Interagency Recovery Teams for the black-capped vireo and golden-cheeked warbler.

1.4 MILITARY MISSION

1.4.1 Military Mission and Strategic Vision of Future Land Use

Fort Hood's mission is to provide an efficient and effective power projection platform—training, mobilization, deployment, and sustainment support—to produce the world's best trained and most lethal war fighters. Fort Hood provides state-of-the-art facilities to support the full spectrum of training requirements of today's modern armed forces. Installation lands and ranges provide excellent training opportunities for mechanized maneuver and small unit exercises, combined arms training, and live-fire training.

Fort Hood's environmental policy is "Protecting what we defend," and the installation is committed to observing applicable federal, state, and local laws and regulations aimed at sustaining the installation and the environment. There is a relationship between the mission and environmental compliance. The lands at Fort Hood are used primarily for military training, and environmental compliance is necessary to preserve the land and its natural resources (Fort Hood, 2004e).

The installation follows a specific set of guiding principles:

- All personnel are responsible for protecting and preserving the environment.
- Minimize or eliminate waste generation from all operations to reduce impact on the air, water, land, and surrounding community.

- Sustain effective partnerships with community stakeholders and remain attentive to their concerns.
- Prevent pollution.

By preserving natural resources, Fort Hood increases its ability to train Soldiers; therefore, environmental management and sustainability are an integral part of the Fort Hood mission.

1.4.2 Mission Statement

Fort Hood Garrison's Mission. U.S. Army Garrison Fort Hood provides and maintains the installation infrastructure to support power projection and training of Fort Hood units and Soldiers; maintains a quality living and working environment for Soldiers, families, retirees, and authorized civilians; sustains an effective partnership with surrounding communities; serves as Commanding General (CG) Fort Hood's executive agent for mobilization; and supports the III Corps/Fort Hood transformation process.

Fort Hood Garrison's Vision. The Army's model power projection platform, training installation, and community. A "Great Place" to train, work, and live.

1.4.3 Future Mission Requirements

III Corps and Fort Hood proposes to restructure its forces into modular brigades, construct new facilities and supporting infrastructure, and establish three small arms ranges at the installation. Under evolving doctrine, a unit of action (UA) possesses a wide range of combat capabilities extending to combined arms, signal, military police/security, chemicals, logistics, fires, intelligence, engineering and armed reconnaissance. One or more deployed brigade combat teams serving in the UA role would be augmented by a division-level unit of employment (UEx) or a Corps-level unit of employment (UEy) and one or more standardized support UAs. Support UAs would be manned, equipped, and trained for specialized functions: aviation; fires; strike; sustainment; security; maneuver enhancement; or reconnaissance, surveillance, and target acquisition (RSTA).

1.5 INSTALLATION LAND USE

1.5.1 Location and Brief Description

Fort Hood occupies 214,778 acres in central Texas in Bell and Coryell counties. It is 58 miles north of Austin, Texas, and 39 miles southwest of Waco, Texas (Figure 1-1) (USACE, 2003).

The installation has three cantonment areas (designated the Main Cantonment Area, West Fort Hood, and North Fort Hood) on 8,604 acres, two instrumented airfields on 2,915 acres, and maneuver and live-fire training areas on 197,603 acres (Figure 1-2). The cantonment areas have primarily urban land uses. The Main Cantonment Area is at the southern edge of the large, central portion of the installation and is adjacent to Killeen, Texas. West Fort Hood is near Copperas Cove, Texas, in the center of the southern extension of the installation. North Fort Hood is near Gatesville, Texas, in the northernmost part of the installation (USACE, 2003).

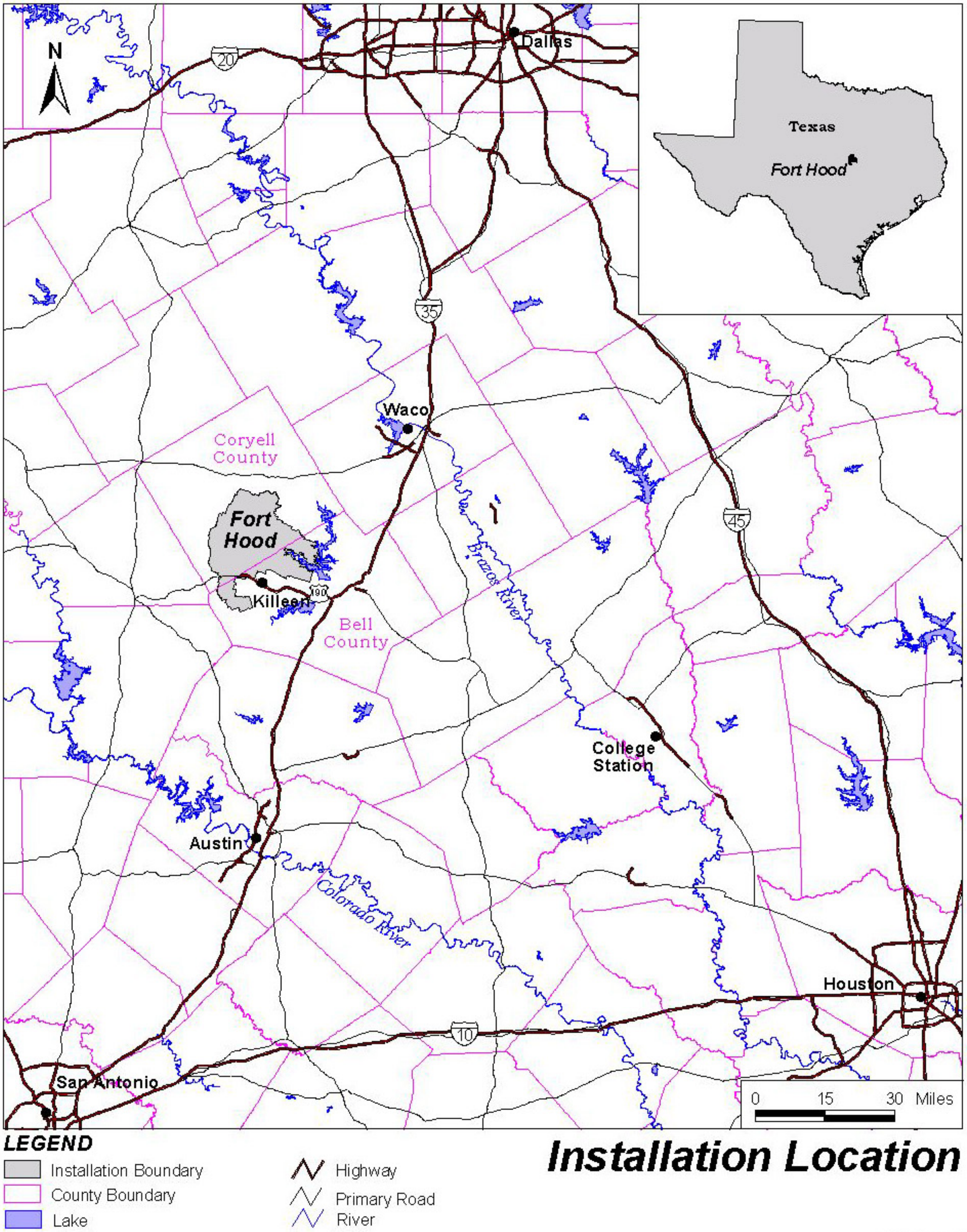
Both urban and rural areas surround Fort Hood. The urban areas include the cities of Killeen, Harker Heights, and Copperas Cove near the southern boundary and the city of Gatesville north of the installation. Urban land uses are primarily residential, business, and industrial. The rural areas surrounding Fort Hood support the agricultural land uses of farming and ranching (cattle). Nearby Belton and Stillhouse Hollow reservoirs provide excellent recreational opportunities for surrounding communities and Fort Hood residents (Fort Hood, 2004a).

1.5.2 Historic Land Use

Before pioneer settlement, Fort Hood was predominately a tall- and mid-grass prairie with scattered stands of oak – juniper woodland. The land on which Fort Hood lies was used primarily for farming and ranching before it became a military installation (Fort Hood, 2001a).

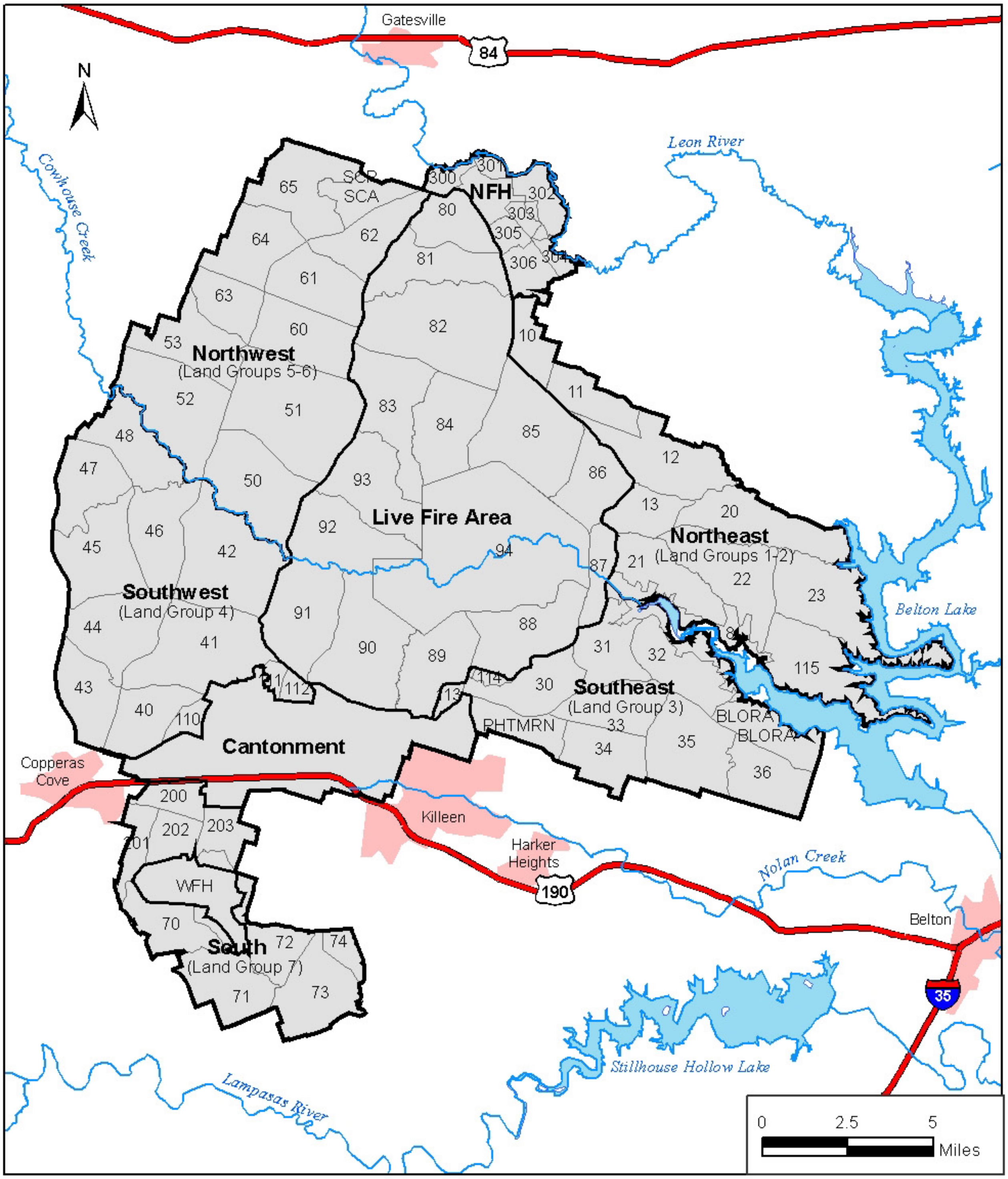
1.5.3 Current Land Use

Land use at Fort Hood is allocated primarily to cantonment areas, maneuver/live-fire training areas, and airfields (Figure 1-2 and Table 1-1). The cantonment areas are essentially urban and contain all the administrative, maintenance, housing, logistical, and other installation support land uses. The maneuver/live- fire training areas are where combat training activities occur. Two airfields are adjacent to the cantonment areas. The Belton Lake Outdoor Recreation Area (BLORA) is at the southeastern edge of the installation adjacent to Belton Lake.



Installation Location

Figure 1-1



LEGEND

Installation Boundary

Region Boundary

94 Training Area Boundary

Source: Fort Hood GIS, 2005.

Installation Map

Figure 1-2

Miscellaneous other land uses, such as roads and easements, traverse the installation's land. Table 1-1 lists land uses and their acreages at the installation (USACE, 2003).

Table 1-1
Land Use at Fort Hood

Primary Land Uses	Acreage	Percent
Training and Live Fire Areas	**197,603**	**92.0**
Heavy maneuver land	85,565	39.8
Light training	48,013	22.3
Local training area	2,297	1.1
Other	350	0.2
Live-fire	61,378	28.6
Cantonment Area and Belton Lake Outdoor Recreation Area (BLORA)	**17,175**	**8.0**
Total Acreage	**214,778**	**100.0**

Source: Paruzinski and Cornelius, personal communication, 2005.

The Main Cantonment Area houses the administrative operations of III Corps, its subordinate commands, and the Garrison Commander. Most of the family and single-Soldier housing and social facilities such as mess halls, gymnasiums, stores, and daycare facilities are in the Main Cantonment Area. Motor pools along its northern edge support all of the installation's motorized operations (USACE, 2003). Hood Army Airfield (HAAF) is adjacent to the Main Cantonment Area (Fort Hood, 2000).

West Fort Hood contains the Robert Gray Army Airfield (RGAAF), research and administrative facilities, support facilities, military personnel housing, and ammunition storage. Training activities on West Fort Hood consist mostly of dismounted training, such as land navigation (USACE, 2003).

North Fort Hood is the primary site for reserve component training and mobilization. Land use activities are similar to those of the Main Cantonment Area but are more limited, and most activity occurs in the summer. North Fort Hood has two auxiliary airfields (USACE, 2003).

The remainder of the installation outside the cantonment areas is primarily used for training and preparedness. More than 60 percent of the land (133,157 acres) is used for maneuver training that involves combat, combat support, and combat service support elements training under simulated battlefield conditions. Training includes infantry, mechanized infantry, armored units, artillery, and air support with helicopters, fixed-wing tactical aircraft, high-speed interceptors, and large bombers (USACE, 2003).

Other land uses on the installation include the Belton Lake Recreation Area (BLORA), roadways, easements, and cattle grazing (Fort Hood, 2000; USACE, Fort Worth District, 1998, 1999).

The installation's training land is divided into two main areas, the Western Maneuver Area and the Eastern Training Area. These areas are further subdivided into six land groups (Figure 1-2) (USACE, 2003).

Land Group 1, in the northeast, is used year-round primarily for tracked vehicle maneuvering. It hosts tanks and Bradley fighting vehicles approximately 28 days per month and additional artillery vehicles approximately 14 days per month. Digging of trenches and fighting positions, construction of obstacles, and use of smoke and pyrotechnics also occur in this land group (USACE, 2003).

Land Group 2, in the northeast, is used year-round approximately 21 days per month, primarily for wheeled and dismounted military police training. It includes core endangered species habitat (discussed in detail in Section 2.0) and has restrictive terrain and vegetation, so training is normally conducted on roads and trails. Only minor digging is conducted in this land group (USACE, 2003).

Land Group 3, in the southeast, is used year-round for some tracked-vehicle maneuver and dismounted training. Tracked-vehicle training is normally restricted to about 15 vehicles. This land group has most of the installation's artillery firing points. Artillery units fire 155mm cannon and Multiple Launch Rocket System rockets from this land group weekly, which accounts for additional tracked-vehicle traffic. Some excavation and use of smoke occurs in this area (USACE, 2003).

Land Groups 4, 5, and 6, the northwestern and central-western portions of the installation, are heavy tracked-vehicle maneuver areas. Training with up to 3,000 vehicles is conducted year-round approximately 21 days per month. Digging of vehicle fighting positions, construction of obstacles, and use of smoke and pyrotechnics also occur in the land groups (USACE, 2003).

The live-fire and impact areas, in the central portion of the installation, do not host much maneuver training. Individual, crew-served, and major weapons systems up to battalion strength are fired in the areas. The range area contains more than 60 firing range complexes, all oriented to direct firing at the large impact area. Traffic in the live-fire and impact area consists of vehicles moving to and from the ranges (USACE, 2003).

1.5.4 Future Land Use

Fort Hood has planned to upgrade a number of ranges to support the modernization of combat vehicles and their missions (Fort Hood, 2004b). The range upgrade projects are listed below:

- BCMU, DMPTR, FY 2005, 52001 (TA 80)LSMU, QTR, FY 2006, PN52000 (TA 64)BKMU, Scout Range, FY 2006, PN52002 (TA 76)CACTF, TA42C, FY 2007, PN57131 (TA 42C)DMMU, Aviation Complex, FY 2008, 52005(TA 61)
- PK/BW, DMPRC, FY 2009, PN49502 (TA 51)BG Complex, MRF, FY 2010, PN52003 (TA 52)SLMU, DMPRC, FY 2010, PN49501 (TA 93)CMPC, DMPRC, FY 2011, PN52006 (TA 74)

Future Development in the Region

The area immediately south of Fort Hood is undergoing rapid urban growth, thus reducing the amount of available agricultural land. Development and improvement of regional transportation routes have accompanied this growth, especially along the I-35 and US 190 corridors. The road system and adjacent railroad lines have added to the urban opportunities of the region and have shaped the expansion into a crescent-shaped corridor that extends from Copperas Cove on the west to Temple on the east. A new joint-use airport, Robert Gray Army Air Field (RGAAF), opened for commercial flight operations in the area of West Fort Hood in 2005. The Killeen-Temple Metropolitan Transportation Plan predicts the region will grow by 69 percent by the year 2020 (K-TUTS, 1999). Community planning is under way to prepare for this influx including the growth attributed to Fort Hood (Fort Hood, 2004a).

1.6 LAND USE PLANNING

1.6.1 Land Use Planning Standards and Decision-Making Processes

Installation training and maneuver areas are subject to multiple uses, and managed by Fort Hood to give consideration to all demands for use of the land and water resources consistent with the military mission, conservation, and environmental concerns.

The primary use of installation lands is for military activities. Leased use of installation lands is subordinate to military requirements, and all leased operations are conducted in a manner that does not interfere with or disrupt military activities.

Fort Hood's Land Use Regulations govern grazing use of training lands. Lessees, or their representatives, must closely coordinate grazing operations with the commander. When livestock are grazing on the installation, lessees must contact the commander at least once every month to maintain adequate coordination between military uses and lessee operations.

The installation reserves certain rights on installation lands subject to lease, including the right to permit use of the land by the public for outdoor recreational purposes, the right to conduct range management programs and projects, and the right to require lessees to remove and withhold all livestock from any designated area when the commander determines that the lands are required for military training or land management purposes.

It is the express intent of Fort Hood that the land be used in accordance with proper range management practices consistent with concurrent multiple-purpose uses. The lessee is expected to be familiar with and to conduct grazing operations in accordance with the prescribed conservation standards for grazing on perennial grasslands. In particular, the lessee must conduct grazing operations in a manner that gives full consideration to the significant variation in the availability of forage that can occur from year to year and within a grazing season due to the amount and distribution of precipitation, wildland fires, and military training activities. The protection of the soil and its vegetative cover from deterioration by erosion, overutilization, wildfire, noxious and other weed infestation, or other causes is part of proper range management.

1.6.2 Relationship of This INRMP to Other Plans

This INRMP integrates training land requirements for the military mission and the requirements for maintaining the ecological health of the training areas. Fort Hood's primary purpose is the military mission, and the installation must provide a quality training facility to serve that purpose. This goal is achieved through implementation of the INRMP and various other plans and programs that support the military mission. Related plans and programs are discussed below.

Land Sustainment Management Plan (LSMP). The LSMP identifies land repair requirements; holds Installation agencies responsible for land repair and maintenance; and ensures that agencies plan, work, repair, and sustain training lands. The primary installation agencies responsible for sustaining Fort Hood training lands are the Garrison Commander, DPW, and DPTS. Supporting agencies are the USDA-NRCS and Texas A&M University System (TAMUS), Blackland Research Center. Supporting agencies provide expertise for land monitoring, area conditions, trends, health, land repair, conservation and sustainment practices, and compliance to ensure that land repair efforts promote land sustainment.

Land sustainment involves myriad complex issues, and it is the responsibility of the LSMP agencies to protect and sustain the land resources to meet all land use requirements. The agencies balance execution of the LSMP with mission requirements.

Training land sustainment responsibilities focus on both the live-fire training areas and maneuver training areas.

Training Out Area Program. Most land repair and sustainment work occurs under the Training Out Area Program. The program divides the Western Maneuver Area into six sections to balance training requirements and land repairs to sustain the installation. Each Out Area becomes the primary land repair area for the installation. During the year an area is out, training is deferred to restore vegetation and ground cover. Cattle grazing is deferred until forage assessments indicate that adequate forage is available and the area is not scheduled for land repairs or vegetation recovery. With six out areas, each area is normally visited for repairs every 6 years. Priority land repair work can be required outside the Training Out Area Program.

Maneuver Damage Program (MDP). The MDP was designed to maintain maneuver training areas by reporting environmental damage, programming repair work, and monitoring the effectiveness of those repairs. Implementation of the program does not restrict maneuver training opportunities (Fort Hood, 2004c). Maneuver Damage Repair Teams (MDRTs) respond to maneuver damage repair incidents and report damage to Range Control and DPW. Damage is either repaired by the MDRTs or referred to DPW for correction. Refer to the LSMP (Appendix A) for further information on the Maneuver Damage Program (Fort Hood, 2004c).

1.7 STRATEGIC DESIGN OF THE INRMP

1.7.1 INRMP Preparation Methods

The preparation of this INRMP involved the review and analysis of past natural resource management practices, ongoing programs, and the current conditions of the existing resources as detailed in Section 2.0. The review process included interviewing Fort Hood personnel, as well as key individuals from state and federal agencies (e.g., TPWD and USFWS), collecting existing environmental documentation, and conducting field reconnaissance of the installation.

The findings from the interviews, field reconnaissance, and document review process have been synthesized and incorporated into this INRMP using the ecosystem management approach (see Section 1.7.2). Where data gaps exist, inventorying and monitoring programs have been proposed. These programs are designed to collect the data necessary to fill the information gaps and to achieve the objectives of the natural resources management program.

1.7.2 Approach and Strategies

The approach used to develop the discussion of the management strategies for each resource followed three general steps:

- ***Goals and Objectives***. The goal and objectives for the management of the resource, as well as the relationship of the resource to other components of the ecosystem (including the human component) and the military mission, were described.

- ***Management Strategies***. Past management strategies, current conditions, and an array of management strategies based on a more informed knowledge of ecosystem management principles were evaluated and considered to develop management strategies that would achieve the goals and objectives for the resource, as well as those of the overall natural resources management program. An inventory of needs and monitoring programs necessary to generate data to ensure the continued success of the program and to provide the information needed to facilitate the integration of adaptive management techniques was included.

  Adaptive management is a continuing process of action(s) based on planning, monitoring, evaluation, and adjustment. When adequately designed and effectively implemented, the process allows managers to determine how well their actions meet their objectives (whether that is protection of sensitive habitats or maintenance of scenic beauty) and what management steps are needed to increase the chances of achieving the objective.

- ***Other Management Alternatives***. Other management alternatives were considered during the screening process but eliminated because they were incompatible with the requirements of the military mission, ecologically unsound, or economically infeasible. A discussion of these alternatives is included in the INRMP in Section 3 under each applicable resource area.

Ecosystem Management. This INRMP follows the direction set forth in the memorandum issued by the Deputy Under Secretary of Defense for Environmental Security (8 August 1994) regarding implementation of ecosystem management in the DoD. The memorandum states that ecosystem management is to be the basis for management of DoD lands and waters. In this context, ecosystem management includes the following:

Ecological Approach: There will be a shift from individual species management to the management of ecosystems.

Partnerships: Ecosystems cross political boundaries, making the need for cooperation, coordination, and partnerships essential for managing ecosystems.

Participation: Public needs and desires will be emphasized in management decisions.

Information: The best available scientific information will be used to select technologies to be used in managing natural resources.

Adaptive Management: Adaptive management techniques will be incrementally applied as they are identified.

DoD=s overall goal regarding ecosystem management is A... to preserve, improve, and enhance ecosystem integrity. Over the long term, this approach will maintain and improve the sustainability and biological diversity of terrestrial and aquatic ecosystems while supporting sustainable economies and communities.@ The specific principles and guidelines that DoD has identified to achieve this goal are listed below. They are reflected in the management measures set forth in Prescriptions.

- Maintain and improve the sustainability and native biodiversity of ecosystems.
- Administer with consideration of ecological units and time frames.
- Support sustainable human activities.
- Develop a vision of ecosystem health.
- Develop priorities and reconcile conflicts.
- Develop coordinated approaches to work toward ecosystem health.
- Rely on the best science and data available.
- Use benchmarks to monitor and evaluate outcomes.
- Use adaptive management.
- Implement through installation plans and programs.

Ecosystem management recognizes that humans are ecosystem components and that sustainable human activity does not mutually exclude the preservation and enhancement of ecological integrity. Therefore, ecosystem management provides Fort Hood the means to both protect biodiversity and continue to provide high-quality military readiness.

The management measures and strategies that will be implemented at Fort Hood have been developed with consideration for the interrelationships between the individual components of the ecosystem, the requirements of the military mission, and other land use activities. The focus is on maintaining the structure, diversity, and integrity of the biological communities, while recognizing that the Soldiers and military mission are a vital component of the ecosystem. An adaptive management strategy has been incorporated into this INRMP to monitor the temporal and spatial dynamics of the ecosystems and to adjust the management measures and strategies based on improved knowledge and data. The monitoring programs will generate the data needed to determine whether the management measures and strategies are effective in achieving their intended goals and objectives. This management approach will preserve and enhance the natural resources while providing the optimum environmental conditions required to sustain the military mission and realistic training conditions.

1.7.3 Plan Organization

The INRMP is composed of four sections:

1. **Overview** provides general background information about the mission and installation and identifies key issues, as well as any issues that may be unresolved.

2. **Current Conditions/Use** provides a brief baseline condition to be used as background and as a context for future management goals, objectives, and actions to be presented in detail in Section 3.0.

3. **Future Management** proposes an array of management approaches needed to fully integrate natural resources management with military use on the land. This section describes strategies for complying with environmental laws and conserving, managing, and restoring habitats, species, soil, and water. It also addresses inventory, monitoring, and research programs that provide the foundation for sound, performance-based environmental compliance and form the basis for responsive, adaptive management in support of military land and water use requirements.

4. **Implementation** shows how the installation uses scheduling and funding to ensure the implementation of strategies to achieve goals and objectives and the desired future condition, as well as the ways the INRMP will be supported through the implementation of funding options.

The **Appendices** contain the individual plans (components), such as the Endangered Species Management Plan, Karst Management Plan, Wildland Fire Management Plan, Soil Erosion Management Plan, Invasive Species Management Plan.

The **Supplements** present Standard Operating Procedures (SOPs) for various NRMB programs, such as wildlife, grazing, endangered species, hunting, and fishing.

The **Prescriptions** are the specific objectives and projects to be carried out as part of the management plan.

1.7.4 Key Issues

The Fort Hood NRMB must address three key issues to support the military mission and to maintain and conserve the installation's natural resources:

- Minimizing erosion and degradation of training lands resulting from training and grazing.
- Protecting and maintaining black-capped vireo and golden-cheeked warbler habitat.
- Maintaining, and, where possible, increasing vegetative cover to minimize erosion.

These issues are addressed in Sections 2.0 and 3.0.

1.7.5 Implementation of Funding Options

The natural resources program at Fort Hood receives financial support from appropriated funds (e.g., operations and maintenance), funded reimbursements (grazing), and user fees (hunting, fishing, and outdoor recreation). The use of funded reimbursements and user fees is restricted by federal law. For example, funded reimbursements can be used only for grazing-related expenses, and user fees may be used only to fund projects related to hunting and fishing. Expenses not directly associated with grazing management or with hunting, fishing, trapping, and outdoor recreational activities must be funded from appropriated funds.

The following paragraphs describe the funding options expected to be available to support the natural resources program at Fort Hood from 2006 through 2010 and their criteria.

Environmental Program Requirements (EPR) Report. The EPR Report provides the primary means for identifying and documenting all current and projected environmental requirements and resources needed to execute the Army's environmental program. From a stewardship and sustainability standpoint, the commander's adherence to the Army's environmental "must fund" policy is paramount in all mission areas. From a legal obligations perspective, the commander's compliance with the Army's environmental "must fund" policy is mandatory (memorandum, dated 3 August 2001).

- Compliance with the requirements of federal, state, and local statutes, Presidential Executive Orders, and signed executive agreements is mandatory and cannot be waived.
- Compliance with administrative publications that directly implement expressed requirements in a statute or an Executive Order is mandatory and cannot be waived.
- Compliance with administrative publications that implement requirements not directly expressed in a statute or an Executive Order is mandatory unless the responsible proponent grants a waiver or exception.

A key function of the EPR Report is to identify and document environmental program requirements, particularly the priority/must fund requirements. At HQDA, requirements in the EPR Report are compared with Major Command (MACOM) funding levels in the environmental accounts. If program and budget levels are not adequate to cover priority/must fund requirements, reviewers identify the shortfalls to MACOM environmental and/or resource management staff and to Army leadership.

Priority/must fund requirements in excess of environmental funds imply an obligation on the commander to reallocate funds from other sources to achieve compliance or, if prudent, to seek a compliance agreement with the appropriate regulatory authority. Where reprogramming authority is limited, or if program realignments to fund compliance create shortfalls in other programs, the commander must submit these unfinanced requirements, along with anticipated impacts, as per guidance through command resource management channels.

Additional project and program funding criteria, outlined in Chapter 3, Section 3-11, of AR 200-1, *Environmental Sustainability and Stewardship,* are described below

Fish and Wildlife Conservation Funds. Pursuant to 16 U.S.C. ' 670a–f, and as described in AR 200-3, Chapter 6-3, AInstallation commanders will establish fees for hunting, fishing or trapping.@ These fees are solely for defraying costs incurred for fisheries and wildlife management on the installation and are not for the construction of recreational structures such as blinds, deer stands, and fishing piers. Fees are deposited into the AWildlife Conservation, Military Reservations@ Army account 21X5095.

Agricultural Outleasing Funds. All revenue from agriculture and grazing out-leases, forest product sales (not applicable at Fort Hood), or sale of equipment procured with Conservation Reimbursable funds are to be deposited into the Army Agriculture/Grazing Account (account 21F3875.3950, HQDA Budget Clearing Account). Revenues generated from the reimbursable programs are to be used for administration and operational expenses of agricultural leases; initiation, improvement, and perpetuation of agricultural leases; preparation, revision, and requirements of integrated natural resources management plans; and implementation of integrated natural resources management plans. Funds required to make up shortfalls between the funds generated by out-leases and the funds required to operate the agricultural out-leasing program may, if available, come from the Army Agriculture/Grazing Account.

Funding requirements for Army Environmental Programs are identified in the EPR reporting process.

1.7.6 Updating the INRMP

AR 200-1 requires installations to review their INRMPs annually and to revise them as necessary. Major revisions to the INRMP are to be undertaken every 5 years. Previous NEPA documentation should be assessed to ensure that the effects of the natural resources management practices in future INRMP updates have been adequately addressed.

1.8 PENDING AND UNRESOLVED ISSUES

1.8.1 Pending Issues

There are no pending issues at this time.

1.8.2 Unresolved Issues

The primary unresolved issue involves the extent of grazing that will occur on Fort Hood lands. The land that makes up Fort Hood was purchased from the original landowners over a long period. The original landowners have been allowed to graze the lands through the out-lease programs first directly through the owner and later through the Central Texas Cattlemen's Association.

Since the inception of the original lease, grazing has occurred concurrently with military training activities on the installation. These activities include full-scale battle scenarios using tracked and wheeled vehicles, infantry, live-fire munitions, and aerial support.

In recent years, the combined effects of military maneuver and continuous grazing on the training lands at Fort Hood has adversely affected the military mission, readiness, and training, as well as the current condition and long-term sustainability of the training lands. Because there are no fences to contain cattle, the animals are free to move about the installation with little regard for the actual stocking rates on any one training area. As a result, the vegetative communities on many of the training areas have been reduced to species types with shallow root systems that are unsuitable for holding soils and preventing or minimizing erosion. Stormwater runoff has severely eroded the training areas, creating extensive gulleys that impede vehicle and troop movement. This forces Fort Hood to divert its limited financial resources to repairing training lands rather than improving them to meet the ever-increasing demands of training Soldiers. In April 2005, a new 5-year grazing lease was executed with terms to annually assess the forage consumable quantity and military training intensity, considering both when determining a stocking rate for the next grazing year. While the lease itself establishes the methodology, one of the key lease terms is to finalize and implement a Grazing Management Plan that clearly defines the approach and procedures used annually to establish a stocking rate with the overall goal of maintaining and improving the ecological condition of military training lands.

1.9 NATIONAL ENVIRONMENTAL POLICY ACT COMPLIANCE AND INTEGRATION

1.9.1 National Environmental Policy Act of 1969

Under NEPA, federal agencies take into consideration the environmental consequences of proposed major actions. The intent of NEPA is to protect, restore, or enhance the environment through well-informed federal decisions. The act is premised on the assumption that providing timely information to the decision maker and the public concerning the potential environmental consequences of proposed actions will improve the quality of federal decisions. Thus, the NEPA process includes the systematic, interdisciplinary evaluation of the potential environmental consequences expected to result from implementation of a proposed action.

The Council for Environmental Quality (CEQ) was established under NEPA to implement and oversee federal policy in this decision-making process. To this end, CEQ has issued *Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act* (40 CFR Parts 1500–1508). The CEQ regulations specify that an EA must be prepared to

- Briefly provide evidence and analysis for determining whether to prepare an EIS or a Finding of No Significant Impact.

- Aid in an agency's compliance with NEPA when an EIS is unnecessary.
- Facilitate preparation of an EIS when one is necessary.

In addition, according to CEQ regulations (40 CFR Part 1500.2(c)), NEPA's requirements should be integrated "with other planning and environmental review procedures required by law or by agency practice so that all such procedures run concurrently rather than consecutively."

1.9.2 32 CFR Part 651 (AR 200-2)

32 CFR Part 651, *Environmental Analysis of Army Actions* (AR 200-2) (29 March 2002), provides Army guidance and procedures for complying with NEPA and sets forth policy for integrating environmental considerations into Army planning and decision making. Embodying the intent and spirit of NEPA, 32 CFR Part 651 (AR 200-2) directs installations to integrate environmental reviews concurrently with other Army planning and decision-making actions. This regulation specifically identifies the Natural Resources Management Plan as a type of document that should be environmentally reviewed prior to implementation. Therefore, the requirements of 32 CFR Part 651 (AR 200-2) must be addressed in the context of assessing the potential environmental effects of a proposed action to *implement* a Natural Resources Management Plan once it has been developed.

1.9.3 INRMP and NEPA Integration

In the past, the Army and other DoD agencies have prepared NEPA analysis and documentation for proposed actions to implement plans, such as INRMPs, *after* such plans have been developed. Although this approach complies generally with NEPA regulations and policies, it is cumbersome and often results in the inefficient repetition and redundancy associated with developing completely separate documents.

32 CFR Part 651, *Environmental Analysis of Army Actions*, states (in § 651.12(e)) that "Environmental analyses and documentation required by this regulation will be integrated as much as practicable with other environmental reviews…" (40 CFR 1502.25). Section 651.12 (e)(5) identifies as falling into this category "Installation management plans, particularly those that deal directly with the environment. These include the Natural Resources Management Plans (Fish and Wildlife Management Plan, Forest Management Plan, and Range Improvement or Maintenance Plan)."

The CEQ regulations encourage combining NEPA documents with other agency documents to reduce duplication and paperwork (40 CFR 1506.4) so that agencies can focus on the real purpose of the NEPA analysisCmaking better decisions. Although this recommendation is not routinely or regularly followed for a variety of reasons, it is supported by Army leadership, the USEPA, and CEQ.

Army guidelines recommend that the INRMP and its associated NEPA analysis and documentation be prepared concurrently. Recognizing the efficiencies in cost and time that could be realized from a fully integrated approach to the planning development process, Fort Hood has fully integrated the INRMP and its associated NEPA analysis and documentation into a single report. Combining an INRMP and its associated EA is an alternative approach for integrating environmental analysis and documentation. This document has been prepared by using the concurrent and fully integrated NEPA analysis approach. This approach embraces the intent and spirit of NEPA, as well as the requirements of 32 CFR Part 651 and AR 200-1. The resultant "planning assessment" includes a comprehensive description, analysis, and evaluation of all environmental components at a given location. It also formalizes existing natural resource practices and can be used as an effective tool for future planning and decision-making purposes.

The INRMP portion of the document provides management measures that have been developed by considering various alternatives for meeting resource-specific goals and objectives at Fort Hood. The INRMP also provides the rationale for why certain management measures have been selected for implementation and others have not, based on analysis of resource-specific screening criteria. The EA portion of the document carries the INRMP's selected management measures forward as the proposed action. Because other management alternatives are considered and dismissed from further consideration in developing the INRMP, the EA addresses only the proposed action and a no action alternative.

To allow the reader to readily identify elements of the NEPA analysis, Table 1-2 presents a "road map" to the corresponding EA sections embodied in this document. All remaining sections pertain primarily to the INRMP.

Table 1-2
Road Map Indicating NEPA Analysis and Corresponding INRMP Sections

Required NEPA Analysis	Corresponding INRMP Section
The **Executive Summary** briefly describes the proposed action, environmental consequences, and mitigation measures.	Provided immediately following the **Preface**
The **Purpose of and Need for the Proposed Action** summarizes the proposed action's purpose, explains why the action is needed, and describes the scope of the environmental impact analysis process.	**Section 1.9.4**
Description of the Proposed Action and Alternatives describes the proposed action of implementing the INRMP (i.e., the selected management measures) and an alternative to implementing the proposed action (i.e., the no action alternative).	**Section 1.9.5**
Scope of Analysis describes the scope of the environmental impact analysis process.	**Section 1.9.6**
Affected Environment describes the existing environmental setting.	**Section 2.0**
Environmental Consequences identifies potential environmental effects of implementing the proposed action and the no action alternative.	**Section 5.0**
References provides bibliographical information for cited sources.	**Section 6.0**
Persons Consulted provides a list of persons and agencies consulted during preparation of the EA.	**Section 7.0**
Distribution List indicates recipients of the EA.	**Section 8.0**
The **Appendices** include agency consultation letters and supplemental information used to develop the NEPA analysis.	Provided immediately following **Section 8.0**

1.9.4 Purpose of and Need for the Proposed Action

Fort Hood is proposing to implement an INRMP that supports the management of natural resources as prescribed by the plan itself. The purpose of the proposed action is to carry out the set of resource-specific management objectives developed in the INRMP, which would enable Fort Hood to effectively manage the use and condition of natural resources on the installation to protect the natural setting primarily for training purposes. Implementation of the proposed action would support the Army's continuing need to train Soldiers in a realistic natural setting while meeting other mission and community support requirements and complying with environmental regulations and policies.

1.9.5 Description of the Proposed Action and Alternatives

Proposed Action. The proposed action is to implement the INRMP for Fort Hood, Texas. This action would meet the Army's underlying need to train Soldiers in a realistic setting that is in compliance with environmental regulations and policies. The proposal includes natural resource management measures involving geographic areas associated with the contiguous properties of the installation. The INRMP is a "living" document that will be modified (adaptively managed) over time. The proposed action focuses on a 5-year planning period, which is consistent with the time frame for the management objectives described in the INRMP. The proposed action involves putting in place the management measures and objectives presented in Section 3.0 and Prescriptions. Additional environmental analyses might be required as new management objectives are developed over the long term (beyond 5 years). Implementation of some INRMP-related projects might also require evaluation to determine the need for and appropriate level of NEPA documentation.

Alternatives. Alternatives considered for the management of Fort Hood's natural resources are described and evaluated within the sections of this document that address the ecosystem-based management of each specific resource (see Section 3.0). The selection of management measures for the INRMP involved a screening analysis of resource-specific management alternatives. The screening analysis involved the use of accepted criteria, standards, and guidelines when available, as well as best professional judgment, to identify management practices for achieving Fort Hood's natural resource management objectives. The outcome of the screening analysis led to the development of the proposed action. Obviously, an infinite number of permutations of specific management alternatives are possible. Consistent with the intent of NEPA, this process focused on considering a reasonable range of resource-specific management alternatives and, from those, developing a plan that could be implemented, as a whole, in the foreseeable future. It then omitted from detailed analysis management alternatives deemed to be infeasible. Management alternatives considered during the screening process but not analyzed in detail are discussed in Section 3.0, as is the rationale for their being omitted from detailed analysis. Application of this screening process in developing the proposed action (implementation of the management measures contained in the INRMP), eliminated the need to define and evaluate hypothetical alternatives to plan implementation. As a result, the EA that is an integral part of this document formally addresses only two alternatives, the proposed action (implementation of the INRMP) and the no action alternative described below.

No Action. Under the no action alternative, the management measures set forth in the INRMP would not be implemented. Current management measures for natural resources would remain in effect, and existing conditions would continue as the status quo. This document refers to the continuation of existing (baseline) conditions of the affected environment, without implementation of the proposed action, as the no action alternative. CEQ regulations prescribe inclusion of a no action alternative, which serves as a benchmark against which proposed federal actions can be evaluated.

1.9.6 Scope of Analysis

The potential environmental effects associated with the proposed action must be assessed in compliance with NEPA, regulations of the CEQ, and AR 200-2. This EA identifies, documents, and evaluates the effects of implementing the INRMP for Fort Hood. The INRMP addresses the geographic area associated with the contiguous properties of Fort Hood, with particular emphasis on the training areas. As discussed, this EA examines the Army's preferred alternative (the proposed action, as described in Section 1.9.5 and Prescriptions) and a no action alternative (see Section 1.9.5 and Prescriptions). The document analyzes potential environmental effects.

The objective of this analysis is to provide an unbiased evaluation of the environmental consequences of an implementable INRMP for Fort Hood that can guide the installation in the following activities:

- Meeting training needs and military mission requirements
- Achieving natural resource management goals
- Meeting legal and policy requirements, including those associated with NEPA, that are consistent with current national natural resources management philosophies

To meet this objective, an interdisciplinary team of environmental scientists, biologists, planners, engineers, archeologists, historians, and military technicians developed the EA. The team identified the affected environment, analyzed the proposed action against existing conditions, and determined the potential beneficial and adverse effects associated with the proposal.

1.9.7 Interagency Coordination and Review

Interagency participation is invited throughout the process of developing the INRMP. Once the INRMP has been drafted, the EA may be used as a tool to inform decision makers and the public of the likely environmental and socioeconomic consequences of implementing the proposed action and alternatives. In addition, Fort Hood provides for public participation in the NEPA process to promote open communication and better decision making. Public participation is invited throughout the NEPA process for developing the EA portion of the document. The following discussion describes opportunities for agency and public involvement in this project.

Interagency Coordination. On November 17, 2004, formal agency consultation letters were mailed to the USFWS and the TPWD. These letters officially notified USFWS and TPWD of Fort Hood's intent to prepare an INRMP and associated NEPA documentation. The agencies' responses are presented in Appendix B. A list of the persons consulted during the preparation of this INRMP is provided in Section 7.0. Appropriate notes and written records documenting the consultations have been maintained in the official Administrative Record and are hereby incorporated into this document.

Project Review and Comment. The primary responsible agencies (see Section 9.0, Distribution List) will be given an opportunity to review and comment on the stakeholders' draft version of the document. Comments will be incorporated into the document and distributed to these agencies for additional review and comment. These additional comments will be incorporated into the final version of the INRMP/EA, and a Draft Finding of No Significant Impact (FNSI) will be prepared, if appropriate.

Public Participation. The public and concerned organizations, including minority and low-income, disadvantaged, and Native American groups, will be notified of the findings and conclusions of the EA by an announcement of the availability of a FNSI (see Appendix C) in the local newspapers and by the availability of the INRMP/EA for public review for 30 days before Fort Hood implements the proposed action. The FNSI will be published in the *Killeen Daily Herald*, and the INRMP/EA will be made available for public review at Killeen Public Library, 205 East Church Avenue, Killeen, Texas; the Temple Public Library, 100 West Adams Avenue, Temple, Texas; the Copperas Cove Public Library, 501 South Main Street, Copperas Cove, Texas; the Gatesville Public Library, 111 North 8th Street, Gatesville, Texas; and at the Fort Hood Environmental Management Office, located at the Directorate of Public Works (DPW), Environmental Management Branch, Bldg 4219, 77th and Warehouse Avenue, Fort Hood, Texas. The INRMP/EA will also be available online at the Fort Hood DPW Public Notice Web site: http://www.dpw.hood.army.mil/HTML/PPD/Pnotice.htm.

SECTION 2.0: CURRENT CONDITIONS AND USE

2.1 CURRENT USES

2.1.1 Military Mission

Fort Hood dates to 1942, when the Army established Camp Hood to prepare soldiers for tank destroyer combat during World War II. Renamed Fort Hood, it became a permanent installation in 1950. Various armored divisions have been assigned to Fort Hood since 1946.

Fort Hood is the only installation currently assigned two divisions. The installation provides the infrastructure and training lands for the 1st Cavalry Division and the 4th Infantry Division (Mech), III Corps Headquarters and its combat aviation assets, combat support, and combat service support units. With increased emphasis on force structure changes and Base Realignment and Closure (BRAC) initiatives, Fort Hood will likely remain the largest active U.S. installation in terms of assigned personnel. The total assigned personnel authorization is approximately 50,000 soldiers.

Fort Hood provides state-of-the-art facilities to support the full spectrum of training requirements of today's modern armed forces. Installation lands and ranges provide excellent training opportunities for mechanized maneuver and small unit exercises, combined arms training, and live-fire training.

2.1.1.1 Maneuver Training.

Maneuver training exercises are conducted at all unit levels to ensure a combat-ready fighting force. Training programs focus on units attaining and maintaining proficiency in collective tasks that support mission-essential tasks. Units involved in the training process span all echelons from section to corps. III Corps's primary training focus at Fort Hood is the brigade level and below.

Units train as they will fight. Training exercises replicate combat conditions as closely as possible. Combat effects such as smoke, noise, and simulated nuclear, biological, and chemical conditions are integrated into every training event to condition units for operations in a difficult, stressful battlefield environment. Trainers are careful not to "simulate" or "assume away" any facet of a training mission. For example, units conducting defensive operations "dig-in" vehicle fighting positions and actually emplace the barrier and obstacle plan in those areas which have been previously approved for subsurface excavation by environmental and archeological managers. This level of training realism ensures a high level of combat readiness.

Units train for combat in a task-oriented manner. Trainers integrate combat, combat support, and combat service support elements to conduct multi-echelon, combined arms training. Combined arms training involves formations that include members of the entire fighting force. Commanders synchronize the activities of these forces within a battlefield framework that includes maneuver and operations within the deep, close-in, and rear battle areas. Such exercises involve greater depth and rapidity of movement dimensions and, therefore, also incur greater demands for concurrent land use.

Maneuver training areas are located west, east, and southwest of the Live Fire Areas (Figure 1-2). Maneuver training areas constitute 53,300 ha or 61 percent of the entire installation. The West Range Maneuver Training Areas (Land Groups 4–6) provide excellent training opportunities for large armored and mechanized infantry forces. The training area averages 7–10 km east to west and 30 km north to south. The area features a wide variety of terrain and vegetation characteristics that greatly enhance cross country, combined arms maneuver. Because of its large, contiguous size, this is the only maneuver area on Fort Hood capable of supporting brigade-level operations.

The Northeast (Land Groups 1 and 2) and Southeast Range Maneuver Training Areas (Land Group 3) are divided by Belton Lake Reservoir. The northeast sector is heavily vegetated and cross-compartmentalized, providing limited value as a mechanized maneuver area. The southeast sector provides more favorable terrain for mechanized units, but it is only 4–7 km north to south and 15 km from east to west. Because of limited area, the Northeast and Southeast Range Maneuver Training Areas are best suited for unit assembly and logistical areas, artillery firing points, and company- and platoon-level mounted and dismounted training. In addition, these eastern training areas support engineer, combat support, and combat service support training and provide locations for amphibious and river-crossing operations.

The South Maneuver Training Area is not used for maneuver training because of its small size and isolated location. The South Maneuver Training Area (Land Group 7, "South Fort Hood") is separated from the main cantonment area by U.S. Highway 190. This training area includes many restricted areas, including Robert Gray Army Airfield and the Ammunition Supply Point (ASP). The South Maneuver Training Area is used primarily for small mechanized unit and dismounted infantry training and for logistical sites.

2.1.1.2 Live-fire Training.

Weapons proficiency is a critical component of combat power. Fort Hood units train with the most modern and sophisticated weapon systems available. These weapons evolve constantly to stay ahead of advancements in armament technology by threat forces. Fort Hood has some of the most modern live-fire training ranges in the world. These ranges provide realistic combat conditions and scenarios to train crews to exacting standards of gunnery proficiency as well as to test the capabilities of new weapon systems. Live-fire training facilities must be continually upgraded to keep pace with evolving technology and changes in war-fighting doctrine. Fort Hood uses a 5-Year Range Modernization Program to manage upgrades and expansion of existing facilities and new construction projects to meet future training and evaluation requirements. Live-fire training facilities are located primarily in Live-Fire Areas (LF) 80–93 and Permanent Dudded Area (PD)94 (Figure 1-2).

The Live-Fire Areas and PD94 cover about 24,000 ha in the central portion of the installation, bounded on the east, west, and south by the East Range, West Range, and South Range roads, respectively. Direct fire occurs inside these roads and is directed toward the Artillery Impact Area and other target arrays. Indirect fire from artillery and Multiple Launch Rocket Systems (MLRSs) is directed from numerous locations in surrounding maneuver areas. Much of the Live Fire Areas provides a buffer zone for PD94 and has limited impacts from exploding ordnance. The Live-Fire Areas provide training and evaluation facilities for all individual, crew-served, and major weapon systems, up to and including brigade live-fire. The Live-Fire Areas are used by all active units assigned to III Corps and Fort Hood, as well as by attached units from the Army National Guard and the Army Reserve.

Modernized live-fire training facilities require continuous maintenance to maximize range design capability. Sensor devices must be serviced and cleared of concealing vegetation to ensure unimpaired operation. Target arrays must be visible at maximum engagement ranges. A range maintenance program to routinely clear vegetation from target arrays and sensor devices is a critical component of range operation.

2.1.1.3 Aviation Training.

Fort Hood has one of the largest military aviation commands in the United States. The aircraft, primarily rotary-wing, are some of the most modern and sophisticated in the world. Aviation units on Fort Hood train at all echelons from individual through battalion/squadron.

The training tasks accomplished in the training areas include all tactical maneuvers, performed in accordance with each aircraft's aircrew training manual and the unit's standard operating procedures. These maneuvers include nap-of-earth, contour, and low-level flight. Fixed-wing aircraft of the Air Force and Air National Guard also conduct training missions in Fort Hood airspace and use impact areas on the installation for weapon delivery practice.

Fort Hood has two major airfields. The Hood Army Airfield is a 293-ha area at the eastern end of the cantonment area. Hood Army Airfield is the primary airfield for rotary-wing air operations, and it has a 1,436-m (4,712-ft) runway. Robert Gray Army Airfield is an 867-ha area at West Fort Hood, and it has a 3,050-m (10,000-ft) runway. There are several dirt landing strips on the installation for tactical air supply and support training.

Aircraft gunnery for AH-64 units is conducted on multipurpose training ranges and PD94. However, the Dalton-Henson Range Complex (LF 80–82) is used most often for this training. Hellfire missile shots are conducted at Blackwell Multi-Use Range's Impact Area (PD94). Helicopter door gunnery is conducted primarily at Dalton Mountain Range or Crittenburger Range (LF 85 and 86). National Guard and Army Reserve units use the Dalton-Henson Range Complex for aviation training.

2.1.1.4 Operational Testing.

Fort Hood's large maneuver and Live-Fire Areas, coupled with III Corps's modernized force, provide excellent conditions for operational testing of various weapons, equipment, and doctrine. The U.S. Army Operational Test Command (OTC) is a tenant activity at West Fort Hood directly involved in training, doctrine, and combat development of the products that soldiers use on a daily basis and will use on a future battlefield.

Most OTC tests employ "user testing," allowing front-line soldiers to try out new equipment or concepts. The tests generally encompass activities similar to those described in this plan's sections on maneuver, live-fire, and aviation training.

2.1.2 Operations and Activities

2.1.2.1 Relationship between the Military Mission and Natural Resources

The Army recognizes that a healthy and viable natural resource base is required to support the military mission. To be effective, the natural conditions of the training areas on Fort Hood must be maintained to provide realism. Areas that are obviously degraded by previous training activity detract from the realism of the current training activity. Vegetation is necessary for cover and concealment, and therefore areas that are stripped of their vegetation no longer represent the undisturbed lands that might be encountered during real conflicts. The relationship between soils and vegetation is very important in supporting the mission. In addition to providing cover and concealment, vegetation protects soils from erosion. Eroded soils are unable to support vegetation, which results in a loss of realism; eroded areas also represent a safety hazard to the soldiers. This INRMP helps to ensure that environmental considerations are an integral part of planning activities at Fort Hood and that natural resources are protected in accordance with Army regulations and policies.

Ongoing military operations performed in support of the Fort Hood mission might alter the environmental setting and condition of the natural resources. For example, the operation of tanks and other tracked vehicles, as well as standard military practices like the construction of ditches, foxholes, and roads, can result in vegetation loss and soil erosion or compaction. Although even with short-term changes the environmental setting might provide for relatively realistic training opportunities, the absence of long-term management measures to properly conserve and restore natural resources could impede Fort Hood's ability to continue to adequately train soldiers. In addition to the impacts mentioned above, environmental damage can place other artificial constraints on training, such as the following:

- Loss of training acreage
- Decreased tactical maneuverability
- Increased land and natural resource maintenance costs
- Increased safety hazards
- Civil or criminal liability

The trainers and soldiers who use Fort Hood are being trained to be aware of the environmental effects of training and to recognize that their actions in the field directly affect the long-term sustainability of the training lands and their ability to continue training. Training the leaders to understand their environmental stewardship responsibilities can help to prevent environmental degradation during training activities. Implementing appropriate management measures, as well as considering alternatives to these measures as they are developed, limits the potential for serious alterations to the natural resources that are critical to providing a realistic training environment. In addition, such measures likely result in a more effective long-term approach to natural resource protection and conservation.

Because the primary mission of Fort Hood is to conduct readiness training, promote survivability of soldiers, and provide combat-ready forces for worldwide deployment, any environmental initiatives and plans are generally considered secondary and should be managed so as not to inhibit meeting military requirements. It is important to consider limitations due to the presence of naturally occurring resources that cannot be altered, as well as limitations resulting from natural resources that have already been affected.

Existing natural resources on Fort Hood lands can influence the manner in which the Fort Hood mission is executed. Although natural resources provide a realistic training environment for meeting mission requirements, their existence also has the potential to limit certain military plans and activities. For example, topographic features of the land or the presence of wetlands or threatened and endangered species might prevent military activities, such as range construction, from occurring because of the potential for adverse impacts on those sensitive resources. In addition, any permanent degradation of natural resources as a result of ongoing military use would, in turn, ultimately lead to further mission impairment should realistic training conditions no longer be available. Therefore, not only is proper management of natural resources and their use by the military a sound environmental practice, but it also directly supports the Fort Hood mission to provide realistic training. This INRMP considers the effects of such natural resources on the mission. Examples of training activities and their effects on the environment, as well as examples of how degradation to natural resources adversely affects the military mission, are provided in Table 2-1.

Table 2-1
Mission Activities and Their Potential Effects

Activity/Use	**Potential Effects on:**	
	Natural Resources	**Training/Combat Readiness**
Vehicles operated off-road	Degradation of soil, water, and vegetation Erosion gullies Soil compaction Soil and water contamination from field maintenance	Loss of training realism Loss of camouflaging for vehicles and troop locations Safety hazards in eroded areas Contamination of soils could limit availability of training areas Increased maintenance costs
Foxholes and defilades	Soil displacement Erosion; eroded soils unable to support vegetation	Loss of training realism Safety hazards in eroded areas

Table 2-1
Mission Activities and Their Potential Effects (continued)

Bivouac areas	Soil compaction and/or erosion Loss of vegetation/forest understory and overstory	Loss of training realism Loss of camouflaging for vehicles and troop locations Limit usable training areas Litter provides Essential Elements of Information (EEI), such as presence and duration at a location, length of supply lines
Cutting of vegetation for camouflage/field fortifications	Wilting and discoloration of cut vegetation; contrasts with natural background Eventual loss of vegetation	Loss of training realism Exposed fighting position Dead vegetation is easy target for infrared radar
Field maneuvers/ range firing	Soil compaction, erosion, and inversion Loss of vegetation/forest understory and overstory Wildfires from pyrotechnics, tracer ammunition, or shell detonation Litter from ammunition brass, plastic paint ball containers, communication wire, concertina wire Artillery training produces a heavy metals residue	Accidental fires result in loss of usable training areas Loss of training realism Immobilized vehicles mired in mud. Potential administrative restrictions as a result of disturbance to federally protected species or habitat.

Training leaders and soldiers are encouraged to use practices that prevent environmental degradation during training activities (Fort Hood Regulation [FH Reg] 200-1). Implementing environmentally sound training practices, as well as considering alternatives to these practices as they are developed, limits the potential for serious alterations to natural resources that are critical to providing a realistic training environment. In addition, such practices likely result in a more effective, long-term approach to natural resource protection and conservation. Presented below are examples of practices used to avoid permanent and serious environmental degradation at Fort Hood. (Some management measures employed to reduce or prevent environmental degradation of resources at Fort Hood are discussed in other sections.)

Fort Hood Regulation 200-1, *Environment and Natural Resources*, prescribes policies, assigns responsibilities, and establishes procedures for protecting the environment and preserving natural and cultural resources. Commanders are responsible for integrating environmental management principles and environmental protection activities and programs, to the fullest extent possible, into the planning and execution of the command basic mission. The following are measures outlined in FH Reg 200-1 and FH Reg 350-40 to avoid permanent and serious environmental degradation of the training lands at Fort Hood:

2.1.2.1.1 Excavation and Digging

- Units will restore maneuver areas at the completion of training as outlined in FH Reg 200-1.
- Any person, military or civilian, conducting any type of excavation (digging) on Fort Hood is required to obtain an approved Excavation and Water Use permit prior to the start of excavation. See the FH Soil Mining SOP for details.
- Excavations in the maneuver area will be restored to the previous contour.
- Because of the presence of numerous historic properties, caves, fossils, and endangered species areas on Fort Hood, all excavations require coordination.
- Dig the minimum number of emplacements, foxholes, and field fortifications consistent with training objectives. Save topsoil to refill holes once training is completed. Upon completion of training, fill and restore the ground surface where foxholes, battle positions, tank ditches, and emplacements have been dug. Mark unused, open holes to prevent personnel from driving into them until sites are refilled.
- Do **not** excavate within 164 feet (50 meters) of streams, ponds, or lakes, and minimize tactical digging that orients the length of excavations up and down the inclination of slopes. Do not excavate or deposit materials within 33 feet (10 meters) of trees.
- Do **not** excavate within 164 feet (50 meters) of an installation boundary fence, a tank trail, or a paved road.
- The four bermed "free dig" sites are to support training. These sites do not require a dig permit and are adequate to support several units training at the same time. Units using these sites are responsible for site recovery after training events. The sites are in TA 30, LTAs 110 and 112, and NFH 300. Locations are marked on the Installation Training Area Map.
- Excavation sites should be monitored with global positioning system (GPS) devices. If part of an excavation extends outside the approved excavation site or "free dig" site, the unit must stop work and initiate an FHT Form 200-X10 request through the normal approving agencies to dig in the new area.

2.1.2.1.2 Threatened and Endangered Species.

- For military training exercise planning purposes, contact DPW Natural Resources Management Branch (NRMB) for consultation or a site visit regarding planned activities that infringe upon known endangered species nesting areas.

- Vehicular travel through core species nesting areas is **not** considered harmful if such movement is transient and confined to established roads and tank trails.

- In core habitat areas, do **not** drive vehicles or equipment through or over woody vegetation. Other uses of the areas are subject to the specific restrictions promulgated in this regulation.

- During the annual nesting season occurring from 1 March through 30 June, the use of core habitat areas is limited to transient travel on established trails and emergency stops only.

  - The time spent in activities in core bird habitat areas must **not** exceed 2 hours in a calendar day.

  - Do **not** circumvent or defeat this limitation through rotation of subordinate elements, brief displacements, or yielding training areas to other organizations.

  - Drive vehicles on established roads and tank trails.

  - Do **not** create new roads and trails without written permission from DPW NRMB.

  - Park vehicles in open areas.

  - Prevent damage to woody vegetation.

  - Do **not** cut brush or trees within habitat areas.

- Do **not** use smoke or chemical agents in or within 328 feet (100 meters) of core habitat.

- Non-core habitat areas have fewer training restrictions and do **not** appear on the standard Fort Hood military installation map, stock number V782SFTHOODMIM. However, Non-core habitat is included as restricted areas for excavations, and FHT Form 200-X10 will **not** be approved for digging, construction, or other activities in habitat areas that will result in a permanent loss of habitat. In Non-core habitat areas, off-trail maneuver is authorized if necessary to accomplish mission-essential task elements. Use of obscurants is **not** restricted in Non-core habitat. Do **not** clear underbrush for command posts, bivouac, or field dining areas.

- Always protect vegetation against fire. Do **not** start fires. Take necessary precautions to prevent fires, and promptly extinguish fires started accidentally.
- Outdoor fires are unauthorized except as approved by the Directorate of Public Works (DPW) Environmental Division and NRMB.
- Avoid unnecessary use of pyrotechnics and incendiary munitions.
- Report fires immediately to Range Control through frequency modulated (FM) 30:45. When FM radio is **not** available, use the most expedient means available to notify Range Control or the Fire Department.
- Use existing tactical emplacements to the extent possible. Digging or constructing new tactical emplacements within woodlands is unauthorized without an approved excavation and water use permit.
- Do **not** tamper or interfere with cowbird traps (large screen cages). Intentional damage to these traps is prohibited.
- If the military mission requirements conflict with the regulations, the designated S-3 will coordinate with DPW NRMB.

Bald Eagle Restricted Aviation Zone (1 October–31 March)

- Minimize disturbance from low-level helicopter flights and other aviation assets. Flight restrictions will be lifted when no bald eagles have been observed for a period of 2 weeks.

2.1.2.1.3 Plants and Animals.

- Do **not** destroy plants and animals in violation of game and wildlife laws.
- Do **not** cut trees, whether alive or dead, without the approval of DPW NRMB.
- Do **not** clear underbrush in command posts, bivouac, or field dining areas. Hunters and fishermen must consult local fish and game laws, and III Corps and Fort Hood Regulation 210-25 (*Hunting, Fishing, and Natural Resources Conservation*).

Fisheries impoundments off-limits to training are shown in Table 2-2 by name and grid coordinates.

Table 2-2
Fish Impoundments Off-limits to Training

Coordinate	Lakes and Ponds
PV293618	11A
PV296493	31C
PV083418	Clear Creek Lake
PV102349	71A
PV064505	44C
PV078514	44G
PV058462	43C
PV106505	41A
PV102551	41C
PV065550	45B
PV113533	42G
PV170619	51E
PV058536	11B
PV238462	Airfield Lake
PV197467	Birdbath Lake
PV111441	Cantonment A
PV133440	Cantonment B
PV083462	Copperas Cove #3
PV123406	Crossville Lake
PV204467	East Lake
PV128605	Eister Lake
PV275478	Engineer Lake
PV125364	Gray Lake
PV326452	Heiner Lake
PV318479	Larned Lake
PV366448	Nolan Lake

Under Fort Hood's natural resources management and Integrated Training Area Management (ITAM) programs, there are efforts to protect the natural resources needed in military training (see Section 3.0). Sections 2.1.3 through 2.1.15 provide descriptions of existing environmental conditions and reflect the status and condition of the natural resources on Fort Hood lands, the management of which is the subject of this INRMP.

2.1.2.2 Future Military Mission Impacts on Natural Resources

The INRMP is considered a "living" document that is based on several short-, medium-, and long-range planning goals. Short-range goals include activities that are planned to occur in 0 to 5 years, while medium-range goals include activities in a 6- to 10-year period. Long-range goals are usually scheduled beyond 10 years. Because an INRMP is a living document, goals may be revised over time to reflect evolving environmental conditions. In addition, medium- and long-range planning goals eventually become short-range activities that also require implementation.

The primary long-range planning goal at Fort Hood is to continue to train soldiers while supporting environmental strategies and goals that are consistent with Army regulations and policies. With long-range planning goals in mind, Fort Hood has developed several short-range goals for the installation to support the current mission and meet future needs. To that end, this INRMP includes management measures that meet three short-range planning goals:

1. To implement a comprehensive environmental strategy that represents compliance, restoration, prevention, and conservation
2. To improve the existing management approach to protecting natural resources on the installation
3. To meet legal and policy requirements consistent with national natural resources management philosophies.

2.1.3 Facilities and Developed Areas

Fort Hood has three cantonment areas: the Main Cantonment Area, West Fort Hood, and North Fort Hood. They are essentially urban and contain all facilities related to administrative, command, industrial, maintenance, warehousing, housing, logistical, billeting, and other installation support land uses. Combined, the cantonment areas occupy 4 percent of the installation land area. The Main Cantonment Area, at the southern edge of the training area and adjacent to Killeen, is composed of the entire developed portion of the post. The Main Cantonment Area has extensive motor pools that support all the motorized operations along the installation's northern edge. West Fort Hood is south of U.S. Highway 190 and close to the city of Copperas Cove. It contains research and administrative facilities for TEXCOM, support facilities, an airfield, ammunition storage, and housing. North Fort Hood, near Gatesville, is the primary site for Army reserve training and equipment service and storage. It also has two auxiliary airfields.

2.1.3.1 Installation Restoration Sites

The Department of Defense established the Installation Restoration Program (IRP) in 1975 to provide guidance and funding for the investigation and remediation of hazardous waste sites caused by historical disposal activities at military installations. The fundamental goal of the Fort Hood restoration program is to protect human health, safety, and the environment. The Army accomplishes this by eliminating or reducing to prescribed, safe levels any potential risks caused by the Army's past operations.

The IRP is carried out in accordance with all federal, state, and local laws. The primary federal laws are the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and the Superfund Amendments and Reauthorization Act (SARA). CERCLA, passed in 1980, requires the cleanup or remediation of hazardous waste sites created by historical disposal practices. Congress gave the U.S. Environmental Protection Agency (USEPA) responsibility for overseeing compliance with the law. The Resource Conservation and Recovery Act (RCRA) and the National Environmental Policy Act (NEPA) also guide the IRP's activities. Under the IRP, Fort Hood investigates and, if necessary, remediates former disposal and test areas.

Fort Hood has 65 IRP sites, all of which are solid waste management units (SWMUs) and most of which are old landfills (e.g., sanitary or burial pits) (Table 2-3). Thirty-five IRP sites were categorized "No Further Action" (NFA), and a Remedial Investigation/Feasibility Study was completed in 1995. Fort Hood monitors 54 closed SWMUs and 11 active SWMUs. Fort Hood's Installation Action Plan (IAP) sites are summarized below (Salmon, 2004).

Table 2-3
Fort Hood IRP/Solid Waste Management Units (SWMUs)

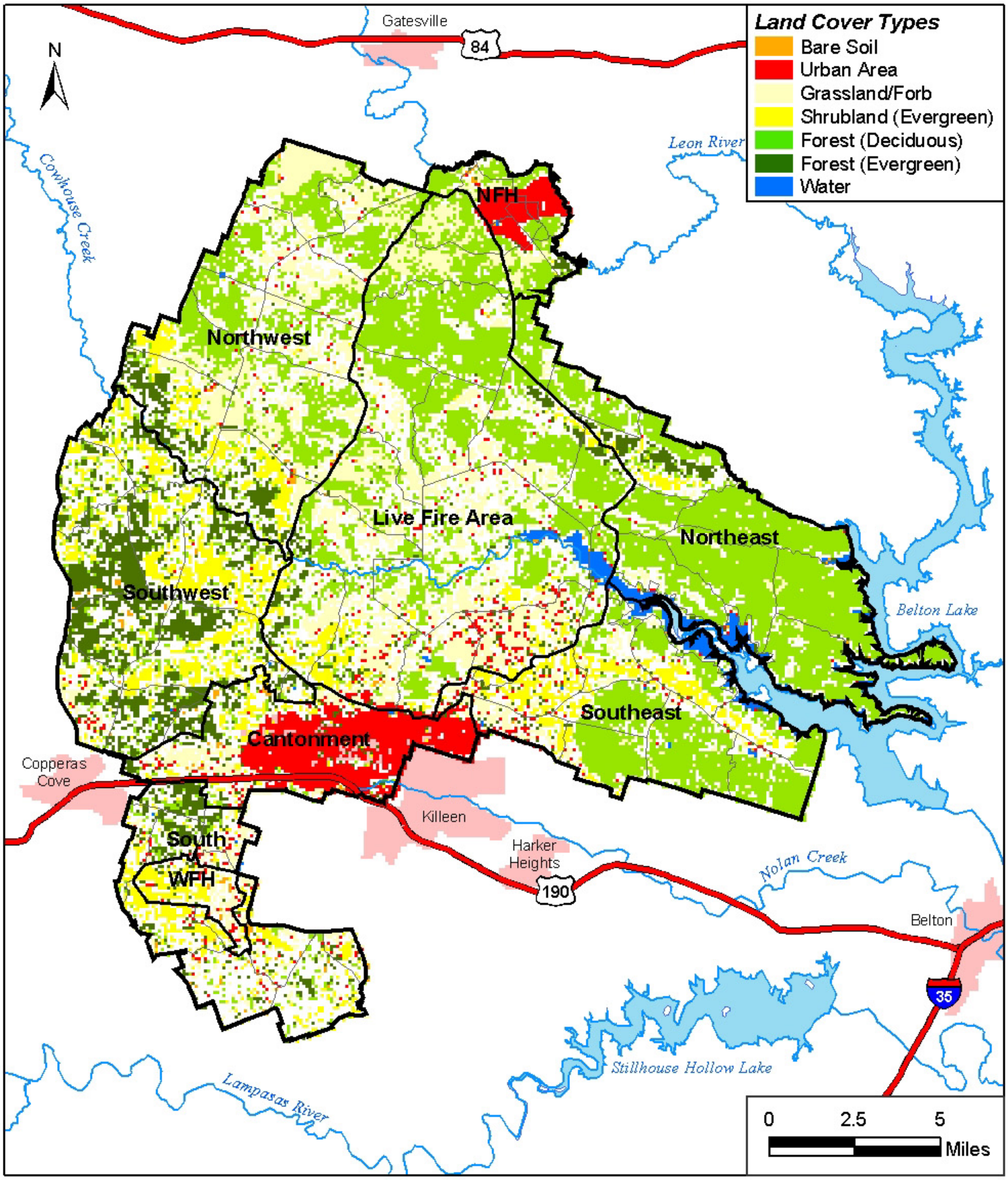
Site IAP Status	Number of Sites
No Further Action (NFA)	47
Closed	7
Active (listed below with SWMU ID No.)	11
Abandoned landfill, Main Cantonment (FH-006)	
NFH wastewater treatment plant, (FH-035)	
BLORA wastewater treatment plant, (FH-036)	
263 underground storage tanks (FH-037A)	
620 used oil aboveground storage tanks (FH-037B)	
Conforming storage 99209 (FH-045A)	
Conforming storage 99210 (FH-045B)	
Per Dudded Areas with impact area (FH-048)	
Washrack drainage discharge, Main Cantonment (FH-052)	
Sanitary sewerage network, Main Cantonment (FH-053)	
DPW classification unit (FH-060)	

Source: Fort Hood DPW, 2004.

2.1.4 Vegetation Management

The two dominant types of vegetation at Fort Hood are Grasslands and Forest and Shrub Communities (Figure 2-1). Historically, mid-grass and tall-grass prairie dominated the region, and frequent range fires throughout the grasslands confined the woody vegetation to the riparian areas and the rocky slopes and hills (USACE, Fort Worth District, 2003). As a result of human activities, including grazing, fire suppression, and training activities, the current vegetation structure and mix of species differ from those expected for these vegetation communities (USDA-NRCS, 1998).

Grassland Communities are found throughout the installation but are most common in the live-fire zone/impact area and in the Western Maneuver Area. Wildfires caused by various training activities in these areas likely reduce the woody vegetation and allow grasses to dominate. Grassland areas are composed primarily of perennial herbaceous species characteristic of mid-grass habitats. Common grass species include little bluestem (*Schizachyrium scoparium*), hairy grama (*Bouteloua hirsuta*), and sideoats grama (*Bouteloua curtipendula*). Common forbs are broomweeds (*Amphiachyris* sp.), ragweed (*Ambrosia artemisiifolia*), and snow-on-the-prairie (*Euphorbia bicolor*). Remnant patches of tallgrass prairie vegetation are dominated by yellow Indiangrass (*Sorghastrum nutans*) and big bluestem (*Andropogon gerardii*) (USACE, 1999).



LEGEND

Installation Boundary

Region Boundary

Training Area Boundary

Source: Fort Hood GIS, 2005; USGS, 2003.

Land Cover

Figure 2-1

Forest and Shrub Communities are a major component of the installation. The majority of these habitats are found on the rocky slopes and hillsides or mesas; smaller amounts of woodlands occur in narrow bands along streams. Over time, Forest and Shrub vegetation has expanded into areas that were once grasslands because of a combination of factors, including fire suppression, training disturbance, and continuous grazing by livestock (USACE, 2003).

Three distinct Forest and Shrub Communities have been classified: Coniferous Forest and Shrub, Deciduous Forest and Shrub, and Mixed Forest and Shrub. Small pockets of Coniferous Forest and Shrub Communities are found throughout the installation and are primarily composed of Ashe juniper (*Juniperus ashei*; commonly referred to as "cedar"), the only coniferous species in the area (USACE, 2003). Another relatively uncommon vegetation association throughout the installation is the Deciduous Forest and Shrub Community. This community is composed of broad-leaf trees and shrubs and is found near streams in lowlands and on protected slopes. Tree species representative of this community include plateau live oak (*Quercus fusiformis*), post oak (*Quercus stellata*), pecan (*Carya illinoiensis*), and sycamore (*Platanus occidentalis*). The most common vegetation community on the installation is the Mixed Forest and Shrub Community. In some areas Ashe juniper dominates over either plateau live oak or Texas oak (*Quercus buckleyi*), and in others the oaks dominate over the Ashe juniper (USACE, 1999, 2000).

The land that makes up Fort Hood was purchased from the original landowners over a period of time. The former landowners have been allowed to graze the lands through outlease programs arranged first directly with the former owners and later through the Central Texas Cattlemen's Association (CTCA). Since the inception of the original lease, grazing has been concurrent with military training activities on the installation (USACE, 2003). Military training has also led to disruption of the soil surface, as well as soil compaction, especially when the activities have occurred during wet periods (USDA-NRCS, 1998). Disruptions to the plant community after military training are further exacerbated by livestock grazing during and after these training activities. The lack of grazing deferral after soil disturbance has subsequently led to a decline in the abundance of perennial grass species and has promoted the invasion of short-lived annual plants that have less extensive root systems, thus making the soil less resistant to erosion (USACE, 2003).

In addition, military activities in combination with livestock grazing have reduced the presence of the fine fuels required to carry range fires. Wildfires, which are a natural component of grasslands, were suppressed to prevent impacts on structures and to minimize the risk to human life. With the suppression of fires and the loss of competitive grasses due to military training and livestock grazing, Ashe juniper and other woody vegetation of the rocky slopes encroached into the grasslands, forming dense thickets in many areas and reducing forage production for livestock and wildlife (USDA-NRCS, 1998). Lack of fire and overuse by livestock have been found to be primary factors leading to increases in Ashe juniper and other woody plants in the Edwards Plateau (Smeins et al., 1997).

The Natural Resources Conservation Service (NRCS) conducted a vegetative resource inventory in 1997 to determine the ecological health of training lands and to recommend livestock carrying capacities for Fort Hood's vegetation (USDA-NRCS, 1998). Eighty percent of all the eastern and western training areas had low (< 25 percent) similarity indices (i.e., the present plant community is less than 25 percent similar to that of the historical climax vegetation for the site). Southern portions of the installation had the highest ecological condition due to 3 to 5 years of grazing deferment, conservative stocking rates, and less military training. The Live Fire Area was in good to excellent ecological condition because of the high frequency of burning and light grazing.

The findings of the vegetative resource inventory indicate that stocking rates were too high on most of the installation and that grazing and training deferments are necessary on all areas void of dense vegetative cover (USACE, 2003). There was also room for improvement in how livestock were distributed on ranges. Active restoration, such as grading eroded areas, ripping compacted soils, and planting perennial vegetation, are necessary for degraded areas to recover. One interesting finding was that rest from military activities and grazing did not necessarily improve site condition. Areas having a lack of military activity and a lack of grazing for 20 years had similarity indices of approximately 25 percent, nearly identical to the indices of areas currently grazed by cattle and used for training. This provides evidence that in the absence of restoration, permanent deferment from military training and livestock grazing is not a solution for improving ecological health (USACE, 2003).

In 2001, the NRCS conducted an inventory in the Western Maneuver Area, the Eastern Training Area, and West Fort Hood to estimate soil erosion and determine rangeland health and trend. Sampling was conducted at permanent vegetation monitoring points that had been established for the data gathered in 1997. Rangeland trend, a rating of the direction of change that might be occurring on a site, was also assessed. Trend defines whether the plant community and the associated components of the ecosystem are moving toward or away from the historic climax plant community or some other desired plant community or vegetation state (USDA, 1997). In the Western Maneuver Areas, both the short- and long-term rangeland trend was found to be declining on the majority of the sites. In the Eastern Training Area, approximately half of the sites showed a downward trend (USDA-NRCS, 2002). At West Fort Hood, most of the sites exhibited an upward trend.

The primary conclusion of the 2001 rangeland health inventory was that declining rangeland health and trend on portions of the installation were the result of increased military training, continuous grazing of livestock without deferment, and the effects of multiyear droughts. The NRCS recommended that livestock and training deferments were needed in much of the Western Maneuver Area and portions of the Eastern Training Area to allow perennial vegetation to increase root biomass and recover (USDA-NRCS, 2002).

In May 2002 the installation performed a vegetation resource inventory similar to the one conducted in 1997 (USACE, 2003). The primary objective of this inventory was to determine the amount of grazeable forage on the installation and to document the species composition and recommend stocking rates (USACE, 2003). Results of this inventory indicated that the amount of perennial forage that could be grazed by cattle was low (< 750 lb/ac) relative to site potential in the majority of the ecological sites in the Eastern Training Area and in the southern portion of the Western Maneuver Area. In the Eastern Training area, sites that had moderate to high productivity (1,000 to 3,000 lb/ac) were generally dominated by King Ranch bluestem (*Bothriochloa ischaemum*). In the North Fort Hood management unit, Texas wintergrass (*Stipa leucotricha)* and Virginia wildrye (*Elymus virginicus*), both native cool season species, constituted approximately 60 percent of the grazeable forage, making this area a candidate for seasonal (winter) grazing. In the West Fort Hood management units, the amount of grazeable forage was generally greater than that of other management units and the sites were dominated by little bluestem (*Schizachyrium scoparium*).

In 2004 Fort Hood carried out another vegetation survey to assess forage resources (Texas A&M, 2004). The 2004 study used the same methods as the 2002 inventory, and it collected vegetation data at 114 study points that had been established during the 2002 inventory. Several additional points were added in the Live Fire Area to collect additional data in areas underrepresented in the 2002 survey. The sampling technique identified plants within survey transects and categorized them according to forage suitability. These data were extrapolated to develop a prediction of the amount of consumable perennial vegetation in each of eight management units. The amount of consumable perennial vegetation was then used to calculate recommended grazing levels in animal units per year under four different management options. Recommended installation-wide grazing levels (in animal units) for management options based on a 25 percent harvest efficiency were 2 to 3 times higher than management options based on a 750- or 1000-pound-per-acre or greater threshold for residue that considered only grazeable acreage within training areas. Training-related reductions in forage availability were factored into the results. The survey also found that the reduction in training and grazing in the Western Maneuver Area appears to have resulted in increased biomass production and litter accumulation. Also, two good growing seasons in the previous 2 years had increased plant litter in all management areas.

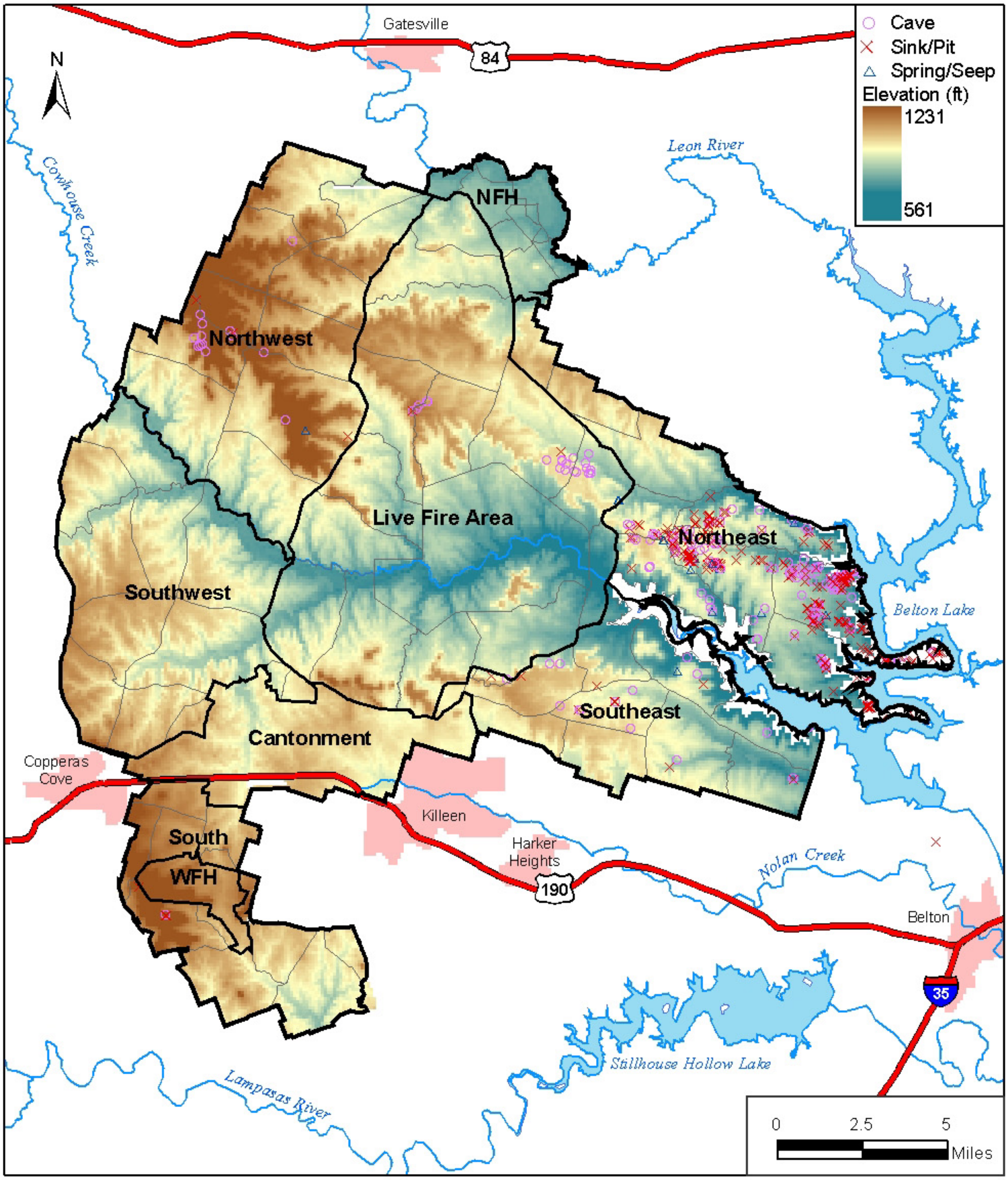
2.1.5 Soil Conservation/Erosion Control Management

2.1.5.1 Geology and Soils Background.

The topography of Fort Hood is defined by rolling hills and steep breaks, and it includes karst topographic features such as caves, sinkholes, and underground springs (Figure 2-2). The underlying geology of Fort Hood is predominantly composed of Cretaceous Age limestone and sandstone formations, and Quaternary deposits are present along major streams. Appendix D provides additional background information on the topography and geology of Fort Hood.

There are 40 unique soil series on Fort Hood (Figure 2-3). In general these soil series are well drained and moderately permeable, but they can vary widely in other characteristics such as depth, parent material, and slope. Five soils that occur on Fort Hood are considered to be hydric soils (USDA-NRCS, August 2005). These soils cover approximately 5,453 acres, or 2.5% of the installation, and are generally located along the stream banks of Cowhouse Creek, Nolan Creek, and Leon Creek and their tributaries (USDA-NRCS, 2005). However, other soils can become hydric, exhibiting anaerobic conditions, as a result of periodic or permanent saturation or inundation. Seventeen soils that occur on Fort Hood are considered to be prime farmland soils. These soils cover approximately 41,800 acres, or 19 percent of the installation. The prime farmland soils are generally located near the main cantonment area, West Fort Hood (WFH), North Fort Hood (NFH), and on floodplains (USDA-NRCS, 2005).

Many of the soils on Fort Hood are naturally susceptible to soil erosion (Figure 2-4). Six soils are categorized as highly erodible, covering approximately 25,700 acres, or 13 percent of the installation. Twenty soils are categorized as potentially highly erodible, covering approximately 164,600 acres, or 75 percent of the installation. The remainder is not highly erodible (USDA-NRCS, 2005). See Appendix D for additional background information on the soils of Fort Hood.



LEGEND

Installation Boundary

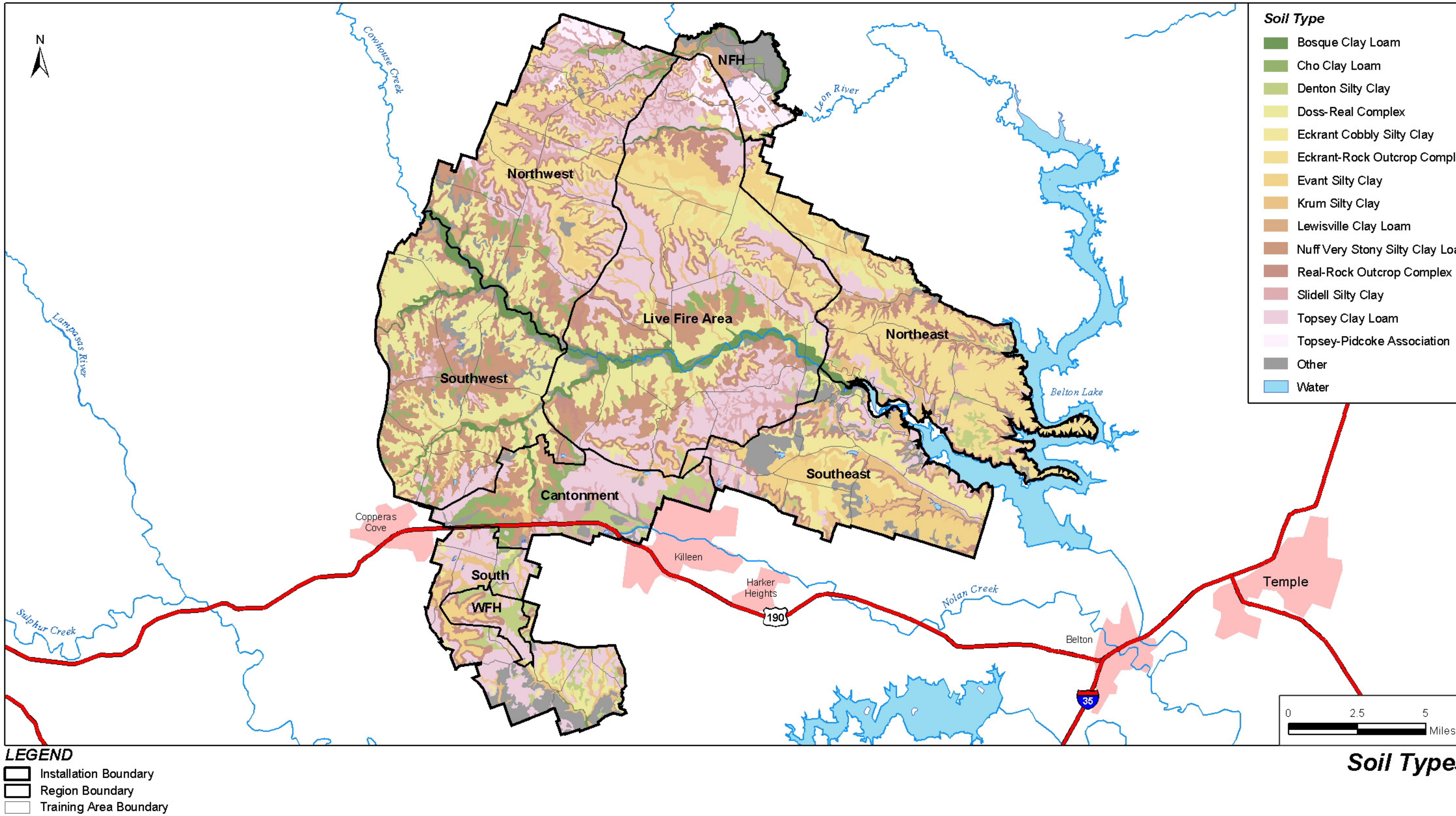
Region Boundary

Training Area Boundary

Source: Fort Hood GIS, 2005; USGS, 1990.

Topography and Karst Features

Figure 2-2

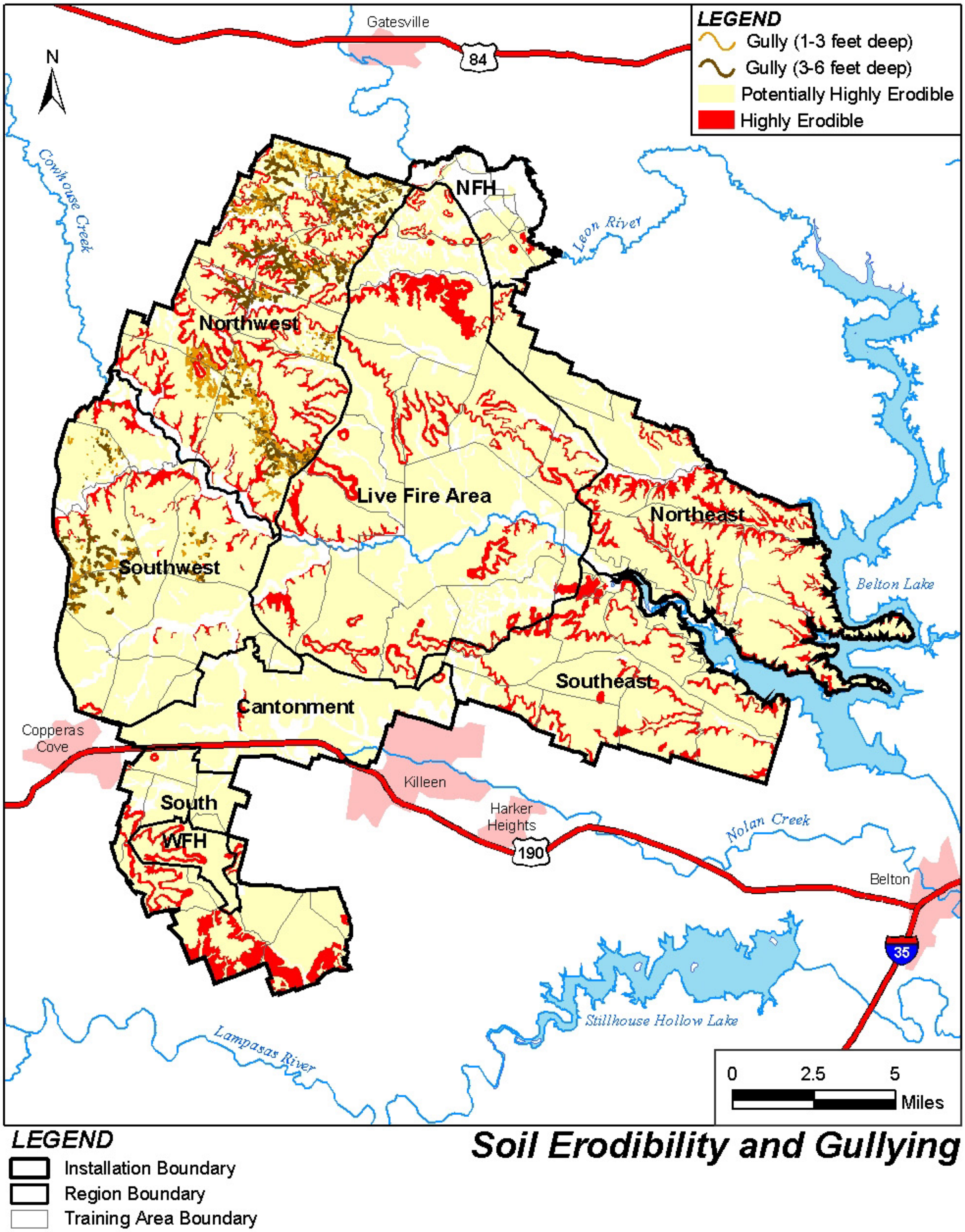


Source: Fort Hood GIS, 2005; USDA, 1977; 1985.

Note: Individual soil map units that represent less than 1 percent of the total area of Fort Hood have been combined as "Other".

Soil Types

Figure 2-3



Soil Erodibility and Gullying

Source: Fort Hood GIS, 2005; USDA NRCS, 1977; 1985.

Figure 2-4

2.1.5.2 Soil Erosion on Fort Hood.

Severe erosion areas are defined as areas with erosion rates exceeding tolerance limits established by the NRCS for each soil type according to its capability to maintain vegetative cover. Soil tolerance levels on Fort Hood range from 1 to 5 tons per acre (USACE, 2003). Soils with higher tolerance values are able to hold soil or withstand erosion better than those with lower values. Soil loss exceeding the tolerance results in sheet, rill, and gully erosion, eventually rendering lands unusable for military training maneuvers. Erosion in areas already bare from previous soil activities, lack of ground cover, or overgrazing is exacerbated by continued effects from military vehicle tracks or wheels. Several areas of the installation, particularly training areas, have extremely high soil erosion rates due to high use by tracked vehicles and cattle grazing, resulting in high sheet, rill, and gully erosion. Loss of perennial vegetative cover (herbaceous and woody vegetation) as a result of heavy training maneuvers has resulted in these high erosion rates and increased bare soil and annual plants in some areas.

Large gullies have developed to a degree that maneuver training cannot be conducted in these areas. The three primary maneuver lanes in the 67,000-acre western training areas of Fort Hood (Northwest and Southwest Regions) contain about 15,000 acres (or about 224 linear miles) of gullies about 3 to 6 feet deep. Much of the gully network is accumulative damage that has occurred over the past 60 years. The damage has accelerated during the past 20 years because the vehicles used for military training have become greater in number, heavier, and faster, causing increased damage to soils and extensive areas of bare soil. Decades of continuous training with no land repair efforts resulted in compacted soils in some areas that did not permit rainfall infiltration needed to sustain perennial vegetative growth. In addition, overutilization by cattle and inadequate land repair funding and command emphasis have contributed to the erosion problem (Fort Hood, 2001a; Fort Hood, 2004d).

Elevated rates of soil erosion appear to have historically affected several caves and sinks on Fort Hood, including 15 caves that were blocked by black topsoil and many additional sinks filled with sediment (Reddell and Veni, 2005).

2.1.5.3 Soil Erosion Monitoring Programs.

Studies are ongoing to determine the contribution of the following activities to soil erosion on Fort Hood (Fort Hood, 2001a):

- Tracked vehicle movement
- Excavation (dig) sites

- Maneuver trails with erosion problems
- Bivouac sites, stream crossings, and hillside trails
- Cattle grazing
- Recreational use

Inventories have been conducted for forage levels and soil erosion rates to identify priority areas for restoration, including the following (Fort Hood, 2001a):

- Fort Hood Erosion and Sedimentation Reduction Project (in cooperation with the NRCS), September 1993.
- Fort Hood Vegetative Resource Inventory (in cooperation with the NRCS), May 1998
- Fort Hood Vegetation Survey Project (in cooperation with the NRCS), May 2002 (USDA-NRCS, 2002)
- Tolerance of switchgrass to tracked vehicle disturbance (in cooperation with Texas Agricultural Experiment Station/Blackland Research Center), ongoing
- Soil survey update (in cooperation with NRCS), ongoing
- Annual land condition reports to ITAM (USDA-NRCS, 2004), ongoing

The May 1998 soil erosion inventory compiled by Fort Hood and the NRCS indicated that every western training area had sampling sites that exceeded the maximum tolerance levels for soil loss. Universal Soil Loss Equation (USLE) calculations determined that soil erosion rates were as high as 265 tons per acre on steep, denuded soils (Fort Hood, 2001a).

The NRCS conducted a soil erosion survey and rangeland health study as part of the Land Condition Trend Analysis (LCTA) Program in 2001-02 (USDA-NRCS, 2002). The amount of soil erosion (from sheet and rill erosion) was determined for the Western Maneuver Area, Eastern Training Area, and West Fort Hood. The results of the soil erosion inventory are shown in Table 2-4. The Western Maneuver Area was found to have the greatest amount of soil loss as a result of the high percentage of exposed bare ground and low amounts of vegetation residue on the soil surface. The average bare ground percentage for the western training area sites was 78 percent, and herbaceous perennial production averaged 445 pounds per acre. This was determined to be a result of drought conditions, military training, and continuous grazing without deferment in this area. West Fort Hood was found to have the least soil erosion as a result of the high amount of herbaceous perennial production (2,325 pounds per acre on average) and lower amount of exposed bare ground (25 percent). These conditions were determined to be a result of grazing deferments and lack of tracked vehicle use in the area (USACE, 2003; USDA-NRCS, 2002).

Table 2-4
2002 Estimated Erosion Rates on Fort Hood

Area	Range of Soil Loss (tons/ac/year)	Average Soil Loss (tons/ac/year)	Percent of Sites With Bare Ground	Percent of Sites With Unacceptable Soil Loss Rates
Western Maneuver Area	0.1–25.1	6	78	72
Eastern Training Area	0–7.8	2	N/A	42
West Fort Hood	0.1–3.0	0.7	25	0

Source: USDA-NRCS, 2002.

Between 1997 and 2001, the productivity of grazeable perennial species declined between 46 and 76 percent in the regions across Fort Hood. About 40 percent of the rangeland health sampling sites did not exhibit “stable” health characteristics (USACE, 2003).

As a result of this survey the NRCS recommended the use of scheduled deferments from grazing and military activities in the Western Maneuver Area and recommended that structural improvements (i.e., revegetation and sediment catchments) be made. In the Eastern Training Area, the NRCS recommended rest-rotation grazing to allow plant vigor to increase, thus allowing increased soil protection. No new actions were recommended for West Fort Hood (USACE, 2003).

Another rangeland health study was conducted in 2004 (USDA-NRCS, 2004). The application of methods to deter soil erosion appeared to be yielding positive results. Biomass production in 2004 increased 85, 182, and 111 percent for southeast Fort Hood, the western training areas, and both areas combined, respectively, as compared with the 2002 study. Although there was virtually no change in the average percent bare ground for the sites sampled (39.8 percent in 2004 compared with 39.1 percent in 2002), the number of sites with greater than 75 percent bare ground reduced from 10 percent in 2002 to 2 percent in 2004. Bare ground in the western training area sites decreased from an average of 49 percent to 41 percent. The increase in biomass was attributed to favorable growing conditions, sufficient precipitation, and reduction in training usage (USDA-NRCS, 2004).

*2.1.5.4 Current Erosion Control Management Programs***.**

Optimal amounts of vegetation residue for mid-grass sites should range from 750 to 1,000 pounds per acre following grazing to maintain or improve rangeland health and reduce soil erosion. Year-long training and livestock deferments on selected areas occurred to allow vegetation recovery (USACE, 2003). The western training areas are a top priority because of heavy training use, high erosion rates, and gully formation. Other areas of the installation will be addressed on an as-needed basis or when erosion rates in the western areas are reduced to acceptable levels.

A soil erosion management plan has been developed for the western training areas (Fort Hood, 2001a). This plan includes the following:

- Improved training area access road (tank trail) system
- Construction of hardened stream crossings, hillside access points, staging areas, bivouac sites, and travel lanes
- Construction of diversion terraces and grassed waterways
- Construction of floodwater retention/sediment catchment basins
- Establishment of buffers along riparian zones
- Establishment of perennial vegetation on priority eroding areas
- Closure of eroding trails
- Establishment of permanent excavation (dig) sites
- Establishment of rotation schedules for training and cattle grazing

Fort Hood also employs various erosion mitigation practices (Fort Hood, 2004d), including the following:

- Check dams: Construction of series of rock check dams in gullies to reduce erosion, contain sediment, and provide maneuver access across gullies.

- Ripping: Ripping or fracturing compacted soil or bare ground to aerate the soil and allow growth of grass roots.

- Seeding: Seeding of areas where adequate vegetative cover is lacking.

- Maneuver Damage Program: Program under which training units file a maneuver damage report following training activities and repair damage incurred within their responsibility and capability.

- Sediment retention: Construction of more than 30 sediment catchment basins to reduce sediment loads into Belton Lake.

- Training Out Area Program: Closing of a training area for at least one or two growing seasons to allow the training area to recover naturally or with additional mitigation.

2.1.6 Water Resources

The water resources of Fort Hood can be classified into two main categories—groundwater and surface water. Each of these water resources has its own physical and chemical characteristics, uses, and potential issues. Fort Hood's major uses of water resources primarily involve surface water and include municipal water supply, training, recreation, vehicle maintenance, and aquatic habitat. The following discussion describes the existing water resources at Fort Hood.

2.1.6.1 Groundwater

The major aquifer that underlies Fort Hood is the Trinity Aquifer. Parts of both the outcrop and the downdip are below Fort Hood. The Trinity Aquifer extends through parts of 55 counties of central Texas. Pre-Cretaceous rocks, the Travis Peak formation, the Glen Rose formation, the Paluxy formation, and the Walnut Clay formation are the primary stratigraphic units that occur in the Fort Hood area. The Walnut Clay formation occurs at the surface of the area, while the Paluxy and Glen Rose formations are exposed only along the channels of the Leon River and its tributaries (USACHPPM, 2001).

The Travis Peak formation, which does not outcrop at the surface in Fort Hood, is the deepest and hydrologically the most important stratigraphic unit in the Fort Hood Region. The Hosston and Hensell members of the Travis Peak formation comprise the aquifer system that is the major source of groundwater supply for Fort Hood. The Pearsall Member, which is not an aquifer, separates these two strata. Rainfall on the outcrop and seepage from streams that cross the outcrop function as the primary sources of groundwater recharge for the Hosston and Hensell members of the Travis Peak formation. This outcrop area covers 1,732 square miles and is located 60 to 80 miles to the northwest of Fort Hood, primarily in Comanche and Erath counties (USACHPPM, 2001). No major groundwater resources outside the installation are affected by recharge from within Fort Hood, and recharge that occurs within the installation affects only the small, shallow groundwater supplies that remain on the installation (USACHPPM, 2001).

Potentially sensitive groundwater areas of the Fort Hood region are the outcrop areas of the Paluxy formation and recent alluvial materials within and adjacent to Cowhouse Creek, Henson Creek, and the Leon River, as well as the karst or cave systems found throughout the installation. The aquifers recharged by these areas are relatively shallow, and therefore they could be affected by hazardous material spills and seepage. However, these waters are rarely used (USACHPPM, 2001). Surface water, not groundwater, is the primary water supply for Fort Hood. Currently, there is no known usage of groundwater at Fort Hood.

Groundwater studies have been conducted at Fort Hood, and the results do not show any critical issues directly attributed to the installation. A detailed discussion of these studies is provided in the Water Quality section of this chapter (Section 2.1.6.3).

2.1.6.2 Surface Water

The surface water resources of Fort Hood include 55 miles of rivers and streams, 692 surface-acres of lakes and ponds, and 43 miles of shoreline at Belton Lake. There are 228 water impoundments present on Fort Hood. Twelve of those serve as either wash rack storage facilities or sewage treatment ponds. The remaining impoundments are used for flood control, sediment retention, wildlife and livestock water, and fish habitat (Fort Hood, 2001a).

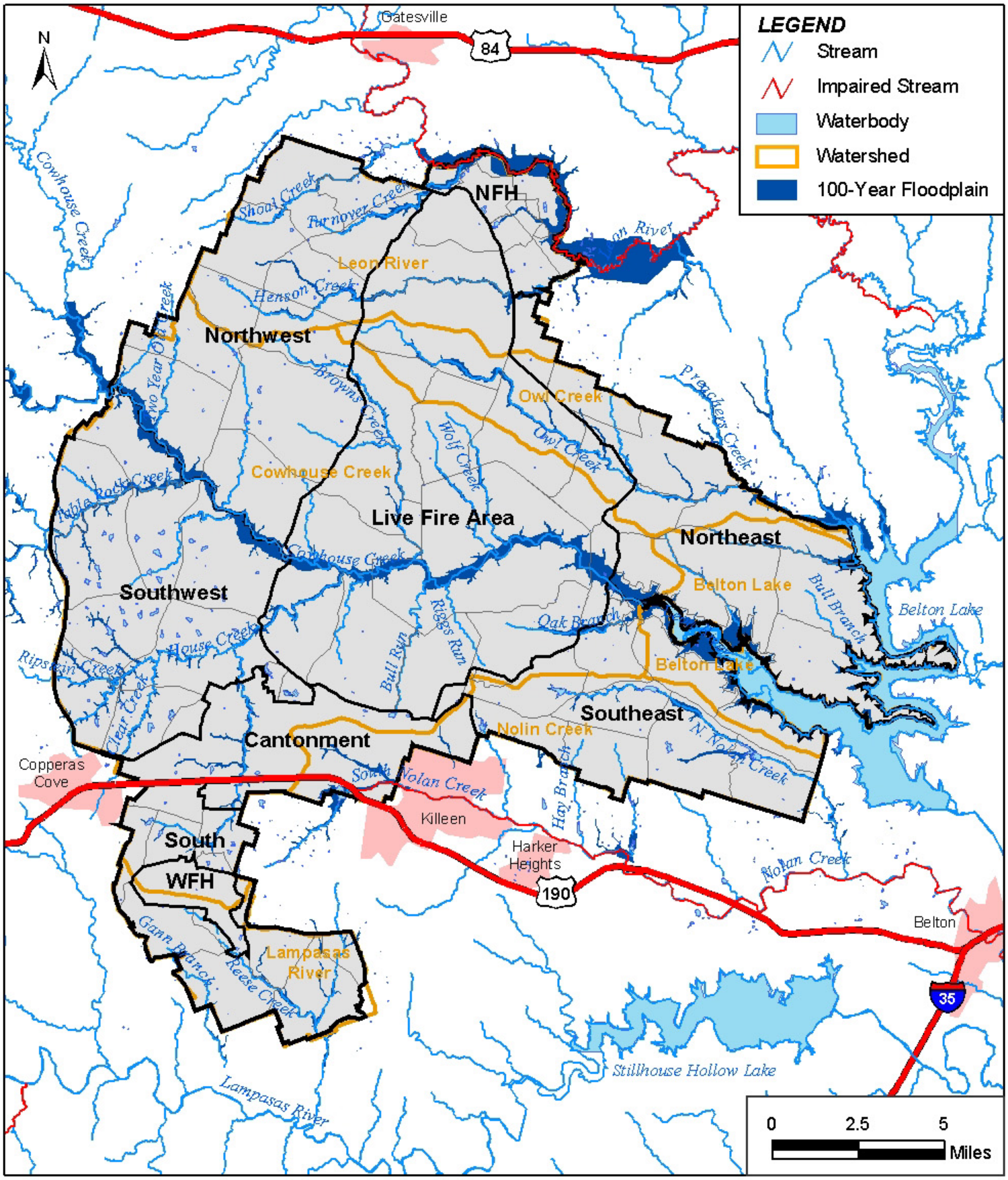
Fort Hood lies within the Brazos River Basin and is a major part of the Leon River watershed. The installation is located directly above two man-made reservoirs—Belton Lake (a sole source water supply for approximately 200,000 people in Fort Hood and surrounding communities) and Stillhouse Hollow Lake (a water supply for several surrounding communities). Both reservoirs function as fish and wildlife habitat and provide flood control and recreation opportunities for the public. Three major drainages to Belton Lake cross the installation, but only a small portion drains into tributaries of Stillhouse Hollow Lake.

Fort Hood can be divided into portions of six large drainages and several smaller subwatersheds (as shown in Figure 2-5). The six main drainages are the Belton Lake watershed, Cowhouse Creek watershed, Lampasas River watershed, Leon River watershed, Nolan Creek watershed, and Owl Creek watershed. These watersheds can be further divided into minor subwatersheds, which include portions of the main stems and tributaries of the major water bodies listed above. Various water quality studies have been conducted to monitor the condition of the water resources across the installation. Through these studies, water quality sampling has taken place at several locations throughout Fort Hood. These locations are shown in Figure 2-6, and the study results are discussed in Section 2.1.6.3. Specific drainage areas, surface water bodies, and water quality issues at Fort Hood are described in detail below according to the best available information. Unless specified otherwise, designated uses for each water body are presumed to be high aquatic life use and contact recreation.

Although precipitation varies from year to year at Fort Hood, most precipitation occurs during May through June and October. January is the driest month of the year. Installation-wide, flooding is not a major problem and is usually of short duration, occurring only after heavy downpours. Flood zone areas are shown in Figure 2-5.

2.1.6.2.1 BELTON LAKE WATERSHED

Belton Lake is a man-made reservoir that is owned and operated by the USACE for flood control, conservation, storage, and recreation. Most of Fort Hood drains to this water body and it is the primary water supply for Fort Hood and surrounding areas. The area classified as the Belton Lake watershed comprises the eastern portion of the installation, just below the point where the Leon River drains into Belton Lake. It includes those areas with shoreline along Belton Lake where all waters drain directly into the lake. This watershed includes tributaries such as Taylor Branch, Bear Creek, Bull Branch, and other unnamed tributaries. The Belton Lake Outdoor Recreation Area (BLORA) is in this watershed, just south of the lake.

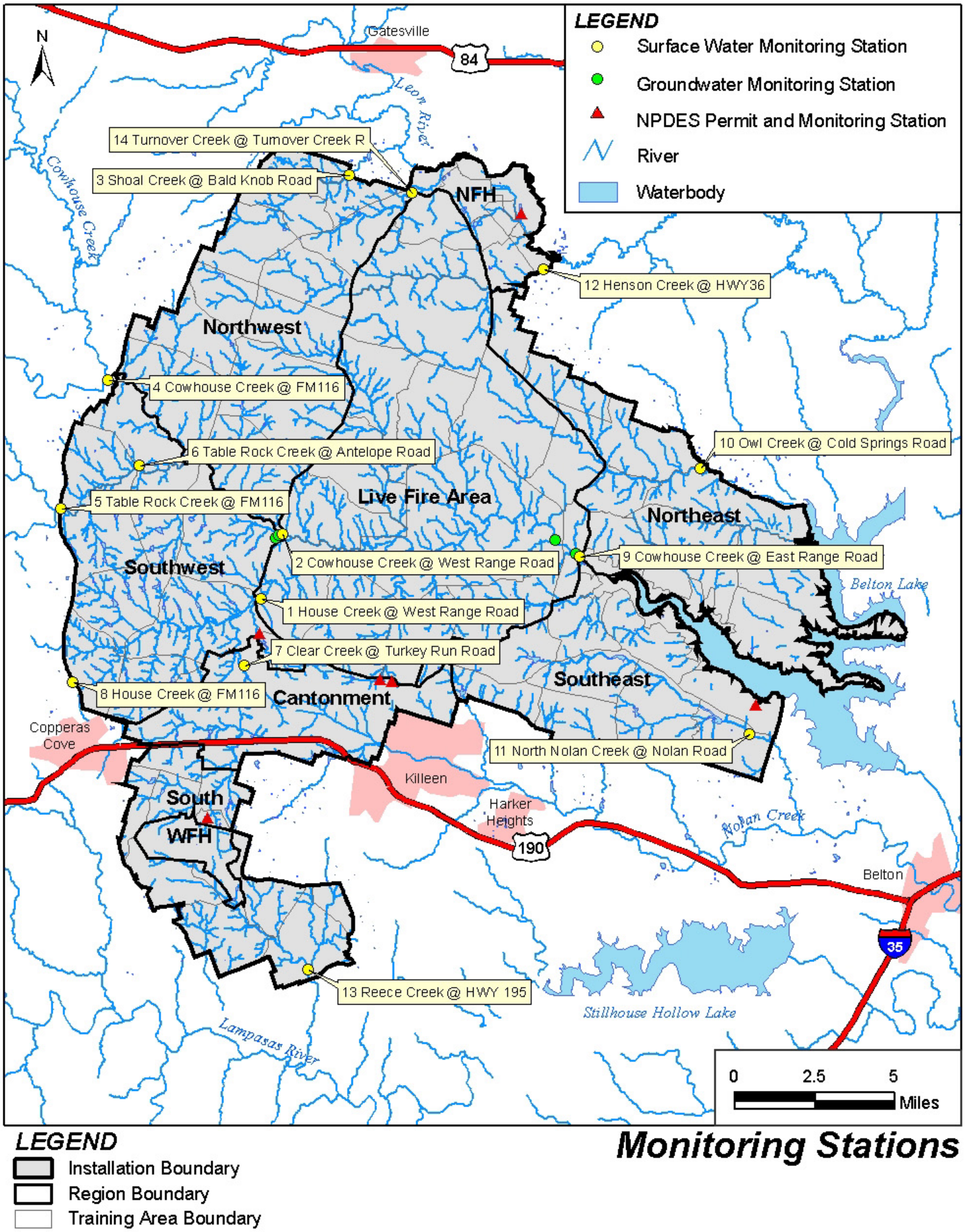


LEGEND
Installation Boundary
Region Boundary
Training Area Boundary

Source: Fort Hood GIS, 2005.

Fort Hood Watersheds

Figure 2-5



Source: Fort Hood GIS, 2005.

Monitoring Stations

Figure 2-6

Belton Lake was impounded in 1954 and has a surface area of 12,300 acres (Texas Parks and Wildlife). In addition to serving as a municipal water supply, the lake is a major site for recreation. It is estimated that nearly 3 million people visit the lake annually for recreational purposes. Designated uses for the lake include contact recreation, high aquatic life support, and use as a public water supply.

2.1.6.2.2 COWHOUSE CREEK WATERSHED

The Cowhouse Creek subwatershed is the largest at Fort Hood, draining more than 50 percent of the surface runoff of the installation. The watershed is close to the center of Fort Hood and extends from the western to the eastern installation boundaries. Cowhouse Creek and its tributaries flow in an easterly direction and drain into Belton Lake. Tributaries to Cowhouse Creek include Beehouse Creek, Browns Creek, Bull Run, Buttermilk Creek, Clear Creek, Cottonwood Creek, House Creek, Oak Branch, Riggs Run, Ripstein Creek, Stampede Creek, Stephenson Creek, Table Rock Creek, Two Year Old Creek, Wolf Creek, and several other unnamed tributaries. Upstream portions of the Cowhouse Creek watershed extend far to the northwest outside Fort Hood's boundaries.

The Cowhouse Creek watershed contains combat training areas where maneuver and live-fire operations occur. This area is heavily affected by these operations in terms of soil disturbance and destruction of vegetation, which results in surfaces prone to erosion and surface water runoff. In turn, sedimentation affects surrounding water resources. There is also a possibility of influence on water resources due to the receipt of surface water runoff that might contain residue from explosives and artillery use in high-explosive-impact areas in the Cowhouse Creek drainage basin.

Studies of the metals, explosives, and perchlorates in the groundwater, surface water, and sediment in this watershed have been conducted. Sedimentation studies have also been conducted in this drainage basin, as well as across the entire installation. In addition, storm water sampling has occurred at seven stations along Cowhouse Creek, House Creek, Table Rock Creek, and Clear Creek. These results are discussed further in the Water Quality section (Section 2.1.6.3) of this chapter.

2.1.6.2.3 LAMPASAS RIVER WATERSHED

A very small portion of the Lampasas River watershed lies within the southern arm of the Fort Hood installation. This watershed contains tributaries to the Lampasas River, including Reese Creek, North Reese Creek, and Clear Creek. These waters drain to Stillhouse Hollow Lake just outside Fort Hood. The Lampasas River (above Stillhouse Hollow Lake) was listed as impaired for bacteria on the 2002 state list of impaired waters required by

Section 303(d) of the Clean Water Act (the 303(d) list). The river is listed again on the 2004 draft list, but additional data and information are to be collected before a Total Maximum Daily Load (TMDL) is scheduled.

2.1.6.2.4 LEON RIVER WATERSHED

Portions of the Leon River watershed are in North Fort Hood. The tributaries in this watershed include Henson Creek, Shoal Creek, Turnover Creek, and Cottonwood Creek. At various points, the Leon River coincides with the boundaries of the installation. Several tributaries feed directly into the Leon River, which drains to Belton Lake. The Leon River (below Proctor Lake) was listed as impaired for bacteria on the 2002 303(d) list. The river is listed again on the 2004 draft list, but it is proposed that additional data and information be collected before a TMDL is scheduled. The Leon River watershed includes urban areas, as well as training areas where maneuver and live fire occur. The Leon River's designated uses include contact recreation, high aquatic life use support, and use as a public water supply.

2.1.6.2.5 NOLAN CREEK WATERSHED

Upstream portions of the Nolan Creek watershed lie in the southeastern portion of Fort Hood. Most of the headwaters of Nolan Creek originate within the installation and flow in a southeasterly direction into the creek. Eventually, Nolan Creek flows into the Leon River below Belton Lake. The portion of the Nolan Creek watershed that is within Fort Hood contains several tributaries, including North Nolan Creek, South Nolan Creek, Shaw Branch, Hay Branch, and several unnamed tributaries. In addition to training areas, this watershed contains most of the urban areas on Fort Hood.

Nolan Creek/South Nolan Creek was listed as impaired for bacteria on the 2002 303(d) list. The creek has been listed again on the 2004 draft list, but it is proposed that additional data and information be collected before a TMDL is scheduled. Nolan Creek is designated for contact recreation and high aquatic life uses.

2.1.6.2.6 OWL CREEK WATERSHED

The Owl Creek watershed is almost entirely within Fort Hood. The watershed is just south of North Fort Hood, and the creek drains directly into Belton Lake. The Owl Creek main stem, as well as numerous unnamed tributaries, flows through Fort Hood before its confluence with Preachers Creek and Belton Lake.

2.1.6.2.7 LAKES AND PONDS

As part of the "hill and lake" country of Central Texas, Fort Hood contains 127 ponds, all of which are suitable for fishing (Fort Hood, n.d.), and 17 lakes, including numerous man-made impoundments across the installation. These are regularly maintained (Fort Hood, 2001a).

Pond Construction. Fort Hood is in the process of having two ponds designed to the point of award by the Corps of Engineers. The sites for these are on Henson Creek tributaries; one is in TA 61 and the other is in NFH 306. Construction of the ponds will not occur until adequate funding is available.

Pond Maintenance. The fish habitats of several of the impoundments on Fort Hood were to be improved with submerged material to increase fish habitat and reproduction and, in turn, to improve fishing recreation. Several lakes were targeted for these improvements from 2000 through 2004.

A nontoxic pond dye was used to control submerged aquatic weeds in the actively managed fisheries ponds during spring and early summer (Fort Hood, 2001a). The mechanical removal of emergent vegetation was used to improve angler access.

Fish kills, massive algal blooms and other pollution indicators were investigated to determine the cause, and corrective action to be initiated. In addition, periodic water analyses were conducted on major lakes and ponds as part of the fish management procedures and any suspected pollution problems were reported to EMD. NRMB monitored the programs to determine whether standards were being met.

2.1.6.3 Water Quality

Water quality studies at Fort Hood include sedimentation and erosion studies, storm water data collection, TPDES permit monitoring, and studies of sediment, groundwater, and surface water in the Cowhouse Creek drainage basin. Each of these is discussed below, and summaries of the available data are presented. The storm water management plan for Fort Hood is also discussed, as well as issues regarding sewage and storm water. The relevant water quality standards and criteria are described first.

2.1.6.3.1 Standards and Criteria

The Texas Surface Water Quality Standards exist to "establish numerical and narrative goals for water quality throughout the state and to provide a basis on which the Texas Commission on Environmental Quality (TCEQ) regulatory programs can establish reasonable methods to implement and attain the state's goals for water quality." Standards are determined according to a water body's status as classified or unclassified. Classified water bodies are all those listed and described in Appendix A or Appendix D in Section 307.10 of the Texas Administrative Code. Site-specific uses and criteria are listed for classified water bodies. Unclassified water bodies are those not specifically listed.

Most of Fort Hood's water bodies are unclassified. Presumed uses of unclassified waters are high aquatic life use and contact recreation, unless specified otherwise, and other specific uses that are attainable or characteristic of the waters. The dissolved oxygen criteria for these water bodies are presented in Table 2-5.

Table 2-6 shows the standards for the classified water bodies on the installation or nearby (and those which receive water from tributaries on the installation) according to the Texas Administrative Code. These criteria do not apply to unclassified water bodies.

Screening levels were established to use as indicators of water quality for parameters for which no established criteria exist. These levels do not apply to classified segments for which site-specific criteria are developed. The water quality screening levels from the *Guidance for Assessing Texas Surface and Finished Drinking Water Quality Data, 2002* are presented in Table 2-7.

Table 2-5
Characteristics and Associated DO Criteria for High Aquatic Life Use Subcategories

Aquatic Life Use Subcategory	Dissolved Oxygen Criteria (freshwater) in mg/L		Aquatic Life Attributes				
	Mean/Min	Spring Mean/Min	Habitat Characteristics	Species Assemblage	Sensitive Species	Diversity	Species Richness
High	5.0/3.0	5.5/4.5	Highly diverse	Usual association of regionally expected species	Present	High	High

Notes:
- Dissolved oxygen means are applied as a minimum average over a 24-hour period.
- Daily minima are not to extend beyond 8 hours per 24-hour day. Lower dissolved oxygen minima may apply on a site-specific basis, when natural daily fluctuations below the mean are greater than the difference between the mean and minima of the appropriate criteria.
- Spring criteria to protect fish spawning periods are applied during that portion of the first half of the year when water temperatures are 63.0EF to 73.0EF.
- Quantitative criteria to support aquatic life attributes are described in the standards implementation procedures.
- Dissolved oxygen analyses and computer models to establish effluent limits for permitted discharges will normally be applied to mean criteria at steady-state, critical conditions.
- Determination of standards attainment for dissolved oxygen criteria is specified in §307.9(d)(6) (relating to Determination of Standards Attainment).

Source: TNRCC, 2000.

Table 2-6
Water Quality Standards for Classified Waterbodies

Segment No.	Segment Name	Uses	Chloride (mg/L)	Sulfate (mg/L)	TDS (mg/L)	DO (mg/L)	pH Range (SU)	Indicator Bacteria (#/100 mL)	Temperature (°F)
1215	Lampasas River Below Stillhouse Hollow Lake	Contact Recreation, High Aquatic Life, Public Water Supply	100	75	500	5.0	6.5–9.0	126/200	91
1216	Stillhouse Hollow Lake	Contact Recreation, Exceptional Aquatic Life, Public Water Supply	100	75	500	6.0	6.5–9.0	126/200	93
1217	Lampasas River Above Stillhouse Hollow Lake	Contact Recreation, High Aquatic Life	500	100	1,200	5.0	6.5–9.0	126/200	91
1218	Nolan Creek/South Nolan Creek	Contact Recreation, High Aquatic Life	100	75	500	5.0	6.5–9.0	126/200	93
1219	Leon River Below Belton Lake	Contact Recreation, High Aquatic Life, Public Water Supply	150	75	500	5.0	6.5–9.0	126/200	91
1220	Belton Lake	Contact Recreation, High Aquatic Life, Public Water Supply	100	75	500	5.0	6.5–9.0	126/200	93

Notes:
- Criteria for chloride, sulfate, and TDS are maximum annual averages.
- DO criteria are minimum 24-hour means.
- pH criteria are minimum and maximum values.
- The indicator bacteria for freshwater are *E. coli*; fecal coliform bacteria is an alternative indicator. Both are listed in the table as follows: *E. coli*/fecal coliform.
- Criteria for temperature are listed as maximum values.

Source: TNRCC, 2000.

Table 2-7
Water Quality Screening Levels

Category	Parameter	Screening Level
Freshwater streams	NH_3-N	0.17 mg/L
	NO_2-N + NO_3-N	2.76 mg/L
	OP	0.5 mg/L
	TP	0.8 mg/L
	Chl *a*	11.6 µg/L
Reservoirs	NH_3-N	0.106 mg/L
	NO_2-N + NO_3-N	0.32 mg/L
	OP	0.05 mg/L
	TP	0.18 mg/L
	Chl *a*	21.4 µg/L

2.1.6.3.2 Permits

Fort Hood has three Texas Pollutant Discharge Elimination System (TPDES) wastewater permits, as shown in Table 2-8. These cover the sewage treatment plant at North Fort Hood, the sewage treatment plant at BLORA, and various vehicle wash activities throughout the installation. Permit limits are shown in Table 2-9. Various best management practices (BMPs) and innovations are employed to limit the potential for pollutants to enter water resources. These include the use of wastewater and storm water detention ponds and four tactical vehicle wash facilities, which treat and recirculation wash water so that no discharges occurs.

Water quality samples are collected regularly at TPDES permit outfall locations to ensure compliance with permit requirements. Water quality and flow data monitoring results are available for six different permit locations (1999 to present). Typically, flow is measured daily and other constituents are measured weekly. A summary of the data collected is shown in Table 2-10.

Table 2-8
Fort Hood TPDES Permit Descriptions

Permit No.	Outfall	General Description	Specific Description	Receiving Water	Major Watershed
TX0002313	001	Vehicle Cleaning and BLORA WWTP	Discharge from oil-water separator at DPW Motor Pool	Tributary of South Nolan Creek	Nolan Creek
	002		Discharge from oil-water separators at Bldg 3851	Tributary of South Nolan Creek	Nolan Creek
	004		Discharge from East Lake	Bull Run Creek, a tributary of Cowhouse Creek	Cowhouse Creek
	005		Discharge from Birdbath Lake	Bull Run Creek, a tributary of Cowhouse Creek	Cowhouse Creek
	006		Discharge from Landfill Lake	Tributary of House Creek	Cowhouse Creek
	010		BLORA WWTP	Tributary of North Nolan Creek	Nolan Creek
TX0063606	001	North Fort Hood WWTP	North Fort Hood WWTP	Tributary of the Leon River	Leon River
TX0063886	001	Vehicle Cleaning (excluding aircraft)	Discharge from Lake D	Tributary of Clear Creek	Cowhouse Creek
	101		Discharge from oil-water separator at Bldg 91057	Lake D, which discharges to a tributary of Clear Creek	Cowhouse Creek
	102		Discharge from oil-water separator at Bldg 90017	Lake D, which discharges to a tributary of Clear Creek	Cowhouse Creek

Note: WWTP = wastewater treatment plant.

Table 2-9
Fort Hood TPDES Permit Limits

Effluent Characteristic	**Discharge Limitations**					
	Daily Avg (lb/day) mg/L	**7-day Avg (mg/L)**	**Daily Max (mg/L)**	**Single Grab (mg/L)**	**Min.**	**Max.**
TX0002313-001, -002, -003						
Flow, MGD	0.020	--	--	--	--	--
Chemical oxygen demand	--	--	200[a]	200	--	--
Total suspended solids	--	--	30[a]	30	--	--
pH, s.u.	--	--	--	--	6.0	9.0
Oil and grease	--	--	15[a]	15	--	--
TX0002313-004, -005, -006						
Flow, MGD	0.020	--	--	--	--	--
Chemical oxygen demand	--	--	200	200	--	--
Total suspended solids	--	--	90	90	--	--
pH, s.u.	--	--	--	--	6.0	9.0
Oil and grease	--	--	15	15	--	--
TX0002313-010						
Flow, MGD	0.020	--	--	--	--	--
Biochemical oxygen	(3.4) 20	--	45	45	--	--
Total suspended solids	(3.4) 20	--	45	45	--	--
pH, s.u.	--	--	--	--	6.0	9.0
Total residual chlorine, mg/L	--	--	--	--	1.0	4.0
TX0063606-001						
Flow, MGD	0.25	--	724[b]	--	--	--
Biochemical oxygen demand (5-day)	(30) 63	45	70	100	--	--
Total suspended solids	(188) 90	--	--	--	--	--
pH, s.u.	--	--	--	--	6.0	9.0
Dissolved oxygen, mg/L	--	--	--	--	4.0	--
TX0063886-001						
Flow, MGD	0.06	--	0.30	--	--	--
Chemical oxygen demand	--	--	150	150	--	--
Total suspended solids	--	--	30	30	--	--
Oil and grease	--	--	15	15	--	--
pH, s.u.	--	--	--	--	6.0	9.0

[a]Limitations are applicable to discharge from each individual treatment facility.
[b]Two-hour average in gallons per minute (GPM).

Table 2-10
Permit Compliance Monitoring Data Summary

	Flow (GPM)	Flow (MGD)	pH (s.u.)	DO (mg/L)	TSS (mg/L)	TSS Load (lb/day)	Oil and Grease (mg/L)	COD (mg/L)	BOD (mg/L)	BOD Load (lb/day)	Total Residual Chlorine (mg/L)
TX0002313-004: 10/5/99–11/30/04											
Count	270	270	267		267		267	268			
Minimum	3	0.004	5.76		1		5.0	30.0			
Maximum	1,000	1.440	8.90		121		18.4	146.0			
Mean	124	0.178	7.71		17		5.3	30.7			
Median	90	0.130	7.85		12		5.0	30.0			
TX0002313-005: 3/30/99–11/30/04											
Count	65	61	61		61		61	61			
Minimum	0	0.006	6.00		2		5.0	30.0			
Maximum	1,004,623	1,446.657	8.70		166		9.5	42.0			
Mean	15,968	24.464	7.53		13		5.3	30.4			
Median	108	0.117	7.57		7		5.0	30.0			
TX0002313-006: 1/5/99–11/30/04											
Count	251	248	236		238		238	238			
Minimum	0	0.000	6.00		1		5.0	30.0			
Maximum	5,568	20.000	8.82		476		30.7	110.0			
Mean	426	0.391	7.76		20		5.4	31.3			
Median	198	0.143	7.94		8		5.0	30.0			
TX0002313-010: 12/18/01–12/14/04											
Count	148	574	150		148	150			146	148	504
Minimum	163,400	0.005	6.40		1	0.00			2	0.00	0.2
Maximum	16,006,600	0.037	8.27		48	7.55			119	8.15	8.8
Mean	8,310,993	0.014	7.40		6	0.78			3	0.34	2.2
Median	8,861,600	0.013	7.44		4	0.43			2	0.25	1.8
TX0063606-001: 1/1/04–12/14/04											
Count	100	129	28	30	28	30			27	29	128
Minimum	0	0.149	7.51	2.4	29	0.00			7	0.00	0.0
Maximum	165	0.238	9.15	8.9	120	216.17			44	79.26	8.0
Mean	128	0.206	7.96	5.7	64	103.95			20	33.00	1.9

Table 2-10
Permit Compliance Monitoring Data Summary

	Flow (GPM)	Flow (MGD)	pH (s.u.)	DO (mg/L)	TSS (mg/L)	TSS Load (lb/day)	Oil and Grease (mg/L)	COD (mg/L)	BOD (mg/L)	BOD Load (lb/day)	Total Residual Chlorine (mg/L)
Median	150	0.216	7.77	6.0	60	100.11			19	29.21	1.8
TX0063886-001: 1/5/99–10/12/04											
Count	209	208	199		200		200	199			
Minimum	0	0.000	5.91		1		5.0	30.0			
Maximum	1,500	2.160	9.50		47		78.3	44.0			
Mean	203	0.271	7.75		7		5.8	30.3			
Median	48	0.052	7.86		4		5.0	30.0			

Notes: DO = dissolved oxygen, TSS = total suspended solids, COD = chemical oxygen demand, BOD = biological oxygen demand. The MDL for COD = 30.0 mg/L and the MDL for oil and grease = 5.0 mg/L. These values were used for non-detects in the calculations to summarize data.

2.1.6.3.3 Storm Water Management

Currently, Fort Hood operates under an industrial storm water permit (TPDES Permit No. TXR05F998) that comes from the general permit, TXR050000. The USEPA has published Phase II Storm Water permitting requirements that include Fort Hood as the owner and operator of a municipal separate storm sewer system (MS4). Therefore, upon adoption of Final TPDES Permit TXR040000, the Fort Hood DPW will be required to file its permit application, which must include a storm water management program (SWMP). The SWMP will direct Fort Hood's compliance efforts for a period of up to 5 years following issuance and will include the following six minimum control measures:

1. Public education and outreach on storm water impacts
2. Public involvement/participation
3. Illicit discharge detection and elimination
4. Pollution prevention/good housekeeping for municipal efforts
5. Construction site storm water runoff control

6. Post-construction storm water management in new development and redevelopment

DPW has been implementing storm water management programs under a general industrial permit and a construction general permit since 1995 and has anticipated the Phase II Storm Water permitting requirements. Therefore, many necessary program management actions are already in place or planned for implementation. Although the program is now in draft format, once implemented, it should ensure that controls that will prevent or minimize water quality impacts are in place (Fort Hood DPW, 2005).

2.1.6.3.4 Sediment and Erosion

Sedimentation is the most prevalent water quality threat at Fort Hood. Training exercises and land practices (e.g., cattle grazing) have resulted in erosion and sediment deposition in water bodies across the installation. Storm water runoff transports eroded soils into nearby water bodies. Erosion and sedimentation have adversely affected the water quality of streams and lakes and reduced the capacity of lakes and ponds. Total suspended solids (TSS) data for streams has been collected at several stations during storm water events as an indicator of sediment input to streams. The physicochemical properties of water bodies, such as turbidity and TSS, can be affected by sedimentation. Across the installation, measurements of sedimentation have been collected in terms of TSS measurements and erosion inventories that were conducted in 1998 and 1999 indicate severe erosion. Most of the TSS values tend to increase with increasing stream level, indicating that high values might be due to storm runoff associated with precipitation.

The Blackland Research and Extension Center (BREC) Water Science Laboratory has been monitoring sediment losses at 13 sites on Fort Hood. (Although 14 stations were originally established, monitoring has been conducted at only 13.) In an effort to monitor restoration and sediment reduction efforts, monitoring included sites in the Shoal Creek watershed. The NRCS installed BMPs in the Shoal Creek watershed, which is in the Leon River drainage, to reduce erosion in this training area to acceptable levels and keep it open for training activities. A discussion of these monitoring efforts and results is included in the Storm Water Data section below.

2.1.6.3.5 Storm Water Data

The BREC conducted water quality and sediment monitoring at 13 Fort Hood sites. The purpose of the monitoring was to determine the effectiveness of the land management practices implemented by the ITAM and the NRCS, including BMPs that were to reduce sediment loading. Further discussion of this study is included in the Soils section (Section 2.1.5) of this chapter. The water quality sampling results are discussed in this section.

In addition to storm water data, grab sample data (from the same period) are discussed on BREC's Fort Hood Water Quality Project Web site (http://waterhome.brc.tamus.edu/projects/fhdata02.html); however, these data were not available. According to the 2000 INRMP for Fort Hood, additional grab sample monitoring was to occur at these stations on a regular basis; however, the status of this monitoring is unknown.

As part of the storm water study, 13 monitoring sites were instrumented with rain gauges, stream level loggers, and programmable water sampling equipment. The sites are listed in Table 2-11 and shown in Figure 2-6. Samples were collected at the sites during storm water events, and results have been used to evaluate the effectiveness of the BMPs. Available storm water data were collected from 1997 to 2002. Note that no data were collected at station number 9 (near the mouth of Cowhouse Creek) because of its proximity to the heavily-dudded Artillery Impact Area (AIA). The data collected include nutrient (nitrate and phosphate) and TSS concentrations, as well as stream level and flow measurements.

Data show that the TSS levels during storm events are 1 to 2 orders of magnitude above typical TSS levels in surface water (in the hundreds and thousands of milligrams per liter). These unusually high measurements could not be verified, although it has been noted in this and other studies that sediment runoff is extremely high during storm events. Analyses did not show any unusual patterns as far as concentration changes during storm events, although very high values of both nutrients and TSS were observed.

2.1.6.3.6 Cowhouse Creek Watershed Studies

The U.S. Army Center for Health Promotion and Preventive Medicine (CHPPM) has conducted studies to investigate the presence of explosive residues and metals in groundwater, surface water, and sediment in and around the AIA at Fort Hood (Geohydrologic Study No. 38-EH-1588-01). The Cowhouse Creek basin captures both runoff and shallow groundwater flow from the impact area and empties into Belton Lake.

Table 2-11
BREC Monitoring Station Locations

Monitoring Station Number	Monitoring Station Location
1	House Creek @ West Range Road
2	Cowhouse Creek @ West Range Road
3	Shoal Creek @ Bald Knob Road
4	Cowhouse Creek @ FM116
5	Table Rock Creek @ FM116
6	Table Rock Creek @ Antelope Road
7	Clear Creek @ Turkey Run Road
8	House Creek @ FM116
9	Cowhouse Creek @ East Range Road
10	Owl Creek @ Cold Springs Road
11	North Nolan Creek @ Nolan Road
12	Henson Creek @ HWY36
13	Reece Creek @ HWY 195
14	Turnover Creek @ Turnover Creek Road

Shallow groundwater discharges to Cowhouse Creek and flows in a general down-valley direction subparallel to Cowhouse Creek. Therefore, the activities within the AIA have the potential to affect the groundwater and surface water in this drainage basin, as well as Belton Lake.

Two sampling events—in April 2001 and March 2004—were conducted as part of the CHPPM studies. Surface water, groundwater, and sediment samples were collected from various sites in the Cowhouse Creek watershed in both studies. A site upstream of the impact area was also sampled to represent reference background conditions. Results from the downstream sites were compared with results from this upstream site, as well as numeric water quality criteria and benchmark values.

Results from the 2001 data show no consistent pattern in metals concentrations for both sediment and surface water samples in the impact area in relation to upstream samples. Explosives or degradates were all below detection limits in surface water and sediment samples. In addition, perchlorate was not detected in any surface water samples. It was determined that the quality of the surface water and sediment in Cowhouse Creek in the impact area, as well as at the mouth of the stream, is good. In the same 2001 study, groundwater monitoring was conducted at three monitoring wells along Cowhouse Creek. Samples were analyzed for metals, explosives, and perchlorate. Metals were present, and the results were higher in the upgradient monitoring well (upstream of the AIA), indicating a lack of effects from the impact area. No explosive compounds were detected in any of the groundwater samples. As with the surface water and sediment results, the groundwater results of this study do not show evidence of contamination. On the basis of these results, the AIA does not appear to have a negative impact on the water resources in the Cowhouse Creek watershed in terms of pollution from metals, explosives, and perchlorate.

The results from the March 2004 CHPPM sample collection are similar to the results from the 2001 monitoring. Three surface water samples were collected at each location. Comparisons were made between the 95 percent upper confidence levels (UCLs) of the MCOC concentrations, calculated from the three samples taken at each location, and the corresponding numeric standard for each detected compound. In the surface water samples, there were only a few detections of explosives, and those detections were very low. There were no exceedances of the criteria or benchmark values for metals in the surface water measurements. RDX, perchlorate, manganese, and vanadium had 95 percent UCL concentrations within an order of magnitude of the selected benchmarks at some sample points; however, no values actually exceeded the benchmarks. The RDX and perchlorate benchmarks are based on human health consumption concerns because the surface water from the range flows into Lake Belton, a drinking water reservoir.

At each well location, groundwater samples were analyzed for selected parameters, including the following: 15 explosive compounds (explosives and their degradation compounds), 16 total and dissolved metals, perchlorates, hardness, and total dissolved solids. No detectable levels of explosives or perchlorates were identified in analyzed groundwater samples. In addition, all results for metals were below respective primary maximum contaminant levels (MCLs) and, as with the results from 2001, the 2004 metals measurements were higher in samples from the upgradient monitoring well. These results do not demonstrate evidence of groundwater contamination from the AIA.

2.1.6.3.7 Sewage and Wastewater

Sanitary sewer overflows have been noted as a potential source of contamination to water resources of Fort Hood. There are records of occasional sanitary sewer overflows across the cantonment, specifically near Clear Creek (near the golf course and along tributaries) and near Nolan Creek (Young, personal communication, 2005). Overflows occur periodically and pose somewhat of an issue regarding water resources. Upon each occurrence, procedures for reporting (to TCEQ) are followed; when fish kills occur, the Texas Parks and Wildlife Department (TPWD) becomes involved. It is estimated that approximately 50,000 to 100,000 gallons of raw sewage flow into water resources each year due to overflows. In 2003 total sewage overflows were estimated at 1 million gallons, a small percentage of which potentially went directly into surface waters (Young, personal communication, 2005). Other potential wastewater issues include those related to latrines, mobile kitchens and showers, and hand-washers used across the installation. It is unknown what impact, if any, these might have on the water resources of Fort Hood; however, procedures are followed to minimize pollution from these temporary units.

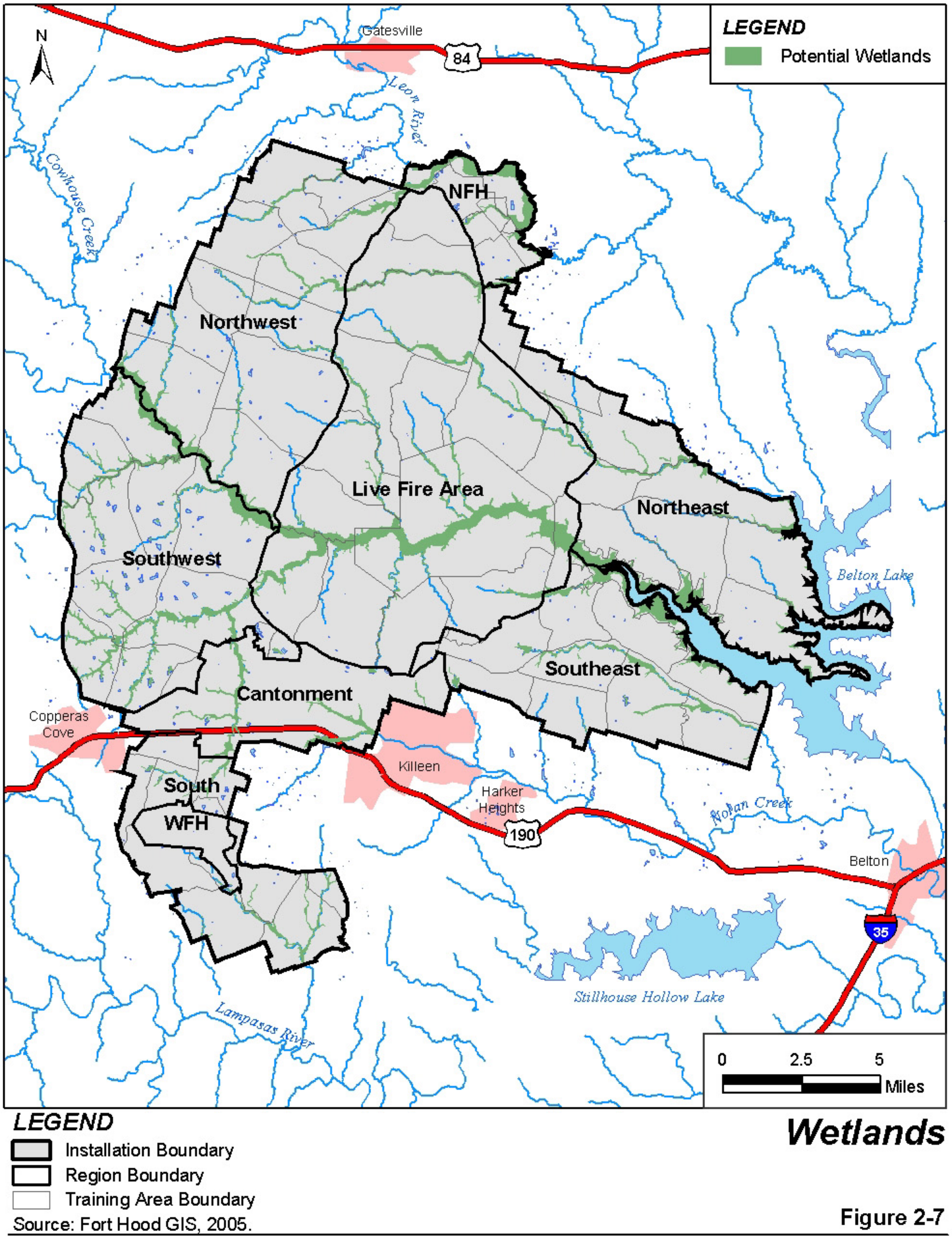
2.1.6.3.8 Conclusions

Various activities at Fort Hood might contribute sediment and other nonpoint source pollutants to nearby water bodies and groundwater. Storm water runoff from training areas could carry sediments, vehicle fluids, and metals, as well as phosphorus and toxics contained within munitions. Surface water quality might also be affected by runoff from agricultural operations in the agriculture outlease areas of the installation. The runoff might contain nonpoint source pollution such as pesticides, sediment, fertilizers, animal waste, and oil and grease.

Comprehensive water quality assessments for the water bodies on the installation are lacking. Moreover, there is no record of habitat or biological assessments on the installation. These concerns are discussed further in Section 3.1.5. Additional water quality information is being sought from the BREC, the Brazos River Authority (BRA), and other sources to help provide a more comprehensive assessment of Fort Hood's water resources.

2.1.7 Wetlands Management

Jurisdictional wetlands in central Texas and at Fort Hood are most common on floodplains along rivers and streams (riparian wetlands), along the margins of lakes and ponds, and in other low-lying areas where the groundwater intercepts the soil (springs). An analysis of existing hydrology, hydric soils, and floodplains was studied to determine areas of high probability for jurisdictional wetlands and waters of the United States. The results of this analysis indicated that potential jurisdictional wetlands within the boundaries of Fort Hood occur along the 692 surface acres of lakes and ponds, as well as tributaries of the waters of the US, including all streams (Figure 2-7). There are numerous natural springs within the Fort Hood Military Reservation boundaries, but not all of their locations have been mapped. Several well-known springs from the area are Ransomer Springs, 8 kilometers north-northwest of Nolanville; Mountain Springs, in the Owl Creek Mountains about 20 kilometers north-northwest of Belton; and Taylor Springs, 2 kilometers south of Mountain Springs (Brune 1981).



Wetlands

Figure 2-7

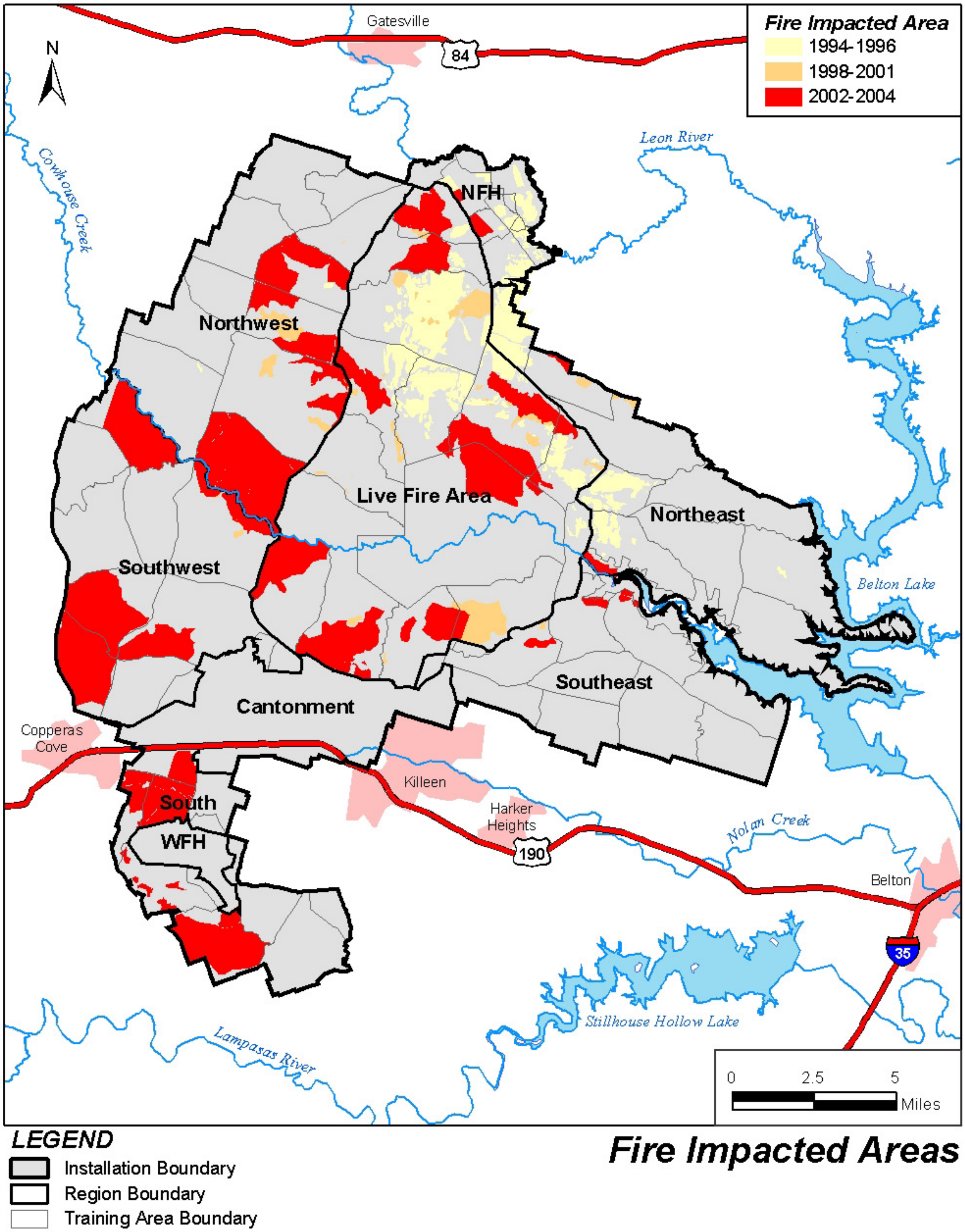
Because no inventory of wetlands at Fort Hood has been performed, there are no formal management activities for the installation. It has been the practice of Fort Hood to exclude potential jurisdictional areas from consideration for construction (direct impacts); however, these areas might be indirectly affected by ongoing installation activities such as military training activities, livestock grazing, hydrologic alterations, and urban and training area storm water runoff.

2.1.8 Fire Management/Prescribed Burning

Fire management in training areas is essential for ensuring safety and maintaining healthy natural systems. Wildfires in the past have caused substantial damage to the habitat of the golden-cheeked warbler, an endangered species, as well as damage to training facilities (see Figure 2-8). However, fire can also have positive effects on natural resources. Prior to European settlement, wildfires were common and helped to maintain the ecological balance between grasslands and forest and shrub communities. Controlled prescribed fire can be a useful tool for maintaining healthy grasslands and controlling invasive shrubs like Ashe juniper. The NRMB plans to increase prescribed burning to improve the ecological condition of the training areas.

Prescribed fire is an appropriate management tool to use in grasslands to control undesirable shrubs and trees, burn dead debris, increase herbage yields, increase the availability of forage, and improve wildlife habitat. Prescribed burning is also used to manipulate habitat for the endangered black-capped vireo, improve open space for military training, and reduce fuel loads to prevent wildfires (Fort Hood, 2001a).

Prescribed burning is an annual management activity beginning in late fall and typically terminating at the end of February. Prescribed fire is also used on a limited basis during the growing season to reduce fuels in fire-prone zones of the live-fire area. Prescribed burning is strictly an NRMB function and is conducted by qualified personnel. The number of acres treated each season depends on weather conditions and the availability of areas not occupied for training. Areas are usually treated on a 5- to 7-year burn cycle, depending on the success of each burn, although some areas might go for longer periods without treatment. Areas overgrazed by cattle and heavily used for training require a shorter cycle because of the reduced fuel load necessary to achieve positive results (Fort Hood, 2001a).



Source: Fort Hood GIS, 2005.

Fire Impacted Areas

Figure 2-8

Most wildfires begin in the Live-Fire Areas (Fort Hood, 2001a). Uncontrolled wildfires are not only detrimental to natural resources and to military training, but they can also threaten areas outside the installation if they cross the boundary. Wildfires occurring during dry periods seriously damage desirable herbaceous plant species and can have a major negative impact on small and large mammals and avian species.

Fort Hood uses a fire danger rating system to alert trainers when pyrotechnic operation should be limited or halted. The system is based on current (daily) weather and the estimated moisture content of vegetation and soil. Details of this rating system can be found in OPLAN 8-93, *Operation Brush Fire* and Fort Hood Regulation 350-40. The fire ratings are as follows:

- **Condition Green:** No restrictions on training. Troops may use pyrotechnics and incendiary munitions for training.
- **Condition Amber:** Caution must be taken in the use of pyrotechnics. Aerial flares are not to be used outside the impact area. Other pyrotechnics are to be used only in roadways, on tank trails, in areas clear of vegetation, or in containers.
- **Condition Red:** No pyrotechnics or incendiary munitions are authorized for training purposes.
- **Condition Red with Waiver:** Once a risk assessment is conducted by Range Control and the recommendation for training with waiver is approved by the Director, Range Control, specific restrictions are imposed on training units.

Under all fire condition ratings, fires are reported to Range Control by military units or installation personnel (Fort Hood, 2004b). If the fires are within range fans where live-fire training is being conducted, units must cease firing until a fire risk assessment is conducted or control measures are implemented. Range Control determines the location of the fire and risk to facilities, personnel, or sensitive resources such as endangered species habitat. If Range Control determines there is no risk to facilities or habitats, the fire is allowed to burn. Typical examples are fires occurring in the permanently dudded impact area, where fires are extremely frequent and fuel loads are low. If a fire might pose a risk to endangered bird habitat, Range Control contacts NRMB for an assessment of the risk based on proximity to high-hazard areas, fuel load, topography, and other parameters. If the fire risk to habitats is obviously high, Range Control may immediately implement fire control actions concurrent with notification of the NRMB.

Prior to March 2005, fire control was implemented under all fire condition ratings if a determination was made that endangered species habitat was at risk from a fire. Within the Live-Fire Areas, the first response is usually made by a contracted helicopter on standby for fire control. Under condition Red, this helicopter is on 30-minute standby during 1100–1800 and 2-hour standby during the rest of the day/night period. Other installation fire-fighting assets are available for fire control as needed.

As part of the overall proposed revisions to the Fort Hood Endangered Species Management Plan (ESMP) (Appendix E), the NRMB proposed modifications to Fort Hood's fire management and protection policies (Fort Hood, 2004b). These modifications reduce requirements to conduct intensive fire suppression in Live-Fire Areas during conditions Green and Amber. Based on a March, 2005 Biological Opinion from USFWS, Fort Hood established a "let burn" policy for range fires that occur during periods when the Fire Danger Rating is Green or Amber. Under Green and Amber ratings, fires are allowed to burn in all habitat areas in the Live-Fire Areas unless there is an obvious threat to personnel or facilities or until such time as changing environmental conditions warrant implementing increased fire control procedures.

The purpose of this modification is to reduce interruption of ongoing live-fire training exercises (Fort Hood, 2004b). In FY 2003, live-fire training was interrupted 1,232 times to suppress fires caused by training activities, for a total downtime of 757 hours. This amount of downtime results in a substantial operational constraint that adversely affects training effectiveness.

Under this modified procedure, Fort Hood will emphasize use of annual preventive prescribed fire to maintain blacklines near habitat areas. Fort Hood will employ firebreaks in association with endangered bird habitats to reduce fire risk.

2.1.9 Fish and Wildlife Management

There are approximately 199,000 acres of mission land suitable for fish and wildlife management. There are 692 surface acres of lakes and ponds, 816 miles of rivers and permanent streams, and 43 miles of shoreline access to Lake Belton. A list of native fish species is provided in Appendix F. Several projects are ongoing and planned to maintain or improve fish and wildlife habitat. Although not intended primarily for the benefit of wildlife, most of the planned elements being installed for other purposes will benefit fish and wildlife.

Current fish habitat management includes the construction of new lakes, lake renovation, dredging for silt removal, bottom contouring, shoreline improvement, aquatic weed management, and dam and spillway repair.

Fort Hood's animal species include most animals indigenous to this part of Texas. Currently five threatened or endangered species are present on or in the vicinity of the installation. For more detailed information, see the Federally Listed Species Managed section (Section 2.1.9.1).

The wildlife habitat management program at Fort Hood is targeted toward restoring the ecological health of the mission lands. The primary needs have been identified as the reduction of the sheet, rill, and gully erosion to acceptable limits; increased native food plants; the reduction of wildfires; and the creation of additional water supplies. A comprehensive list of birds known to occur on Fort Hood and their abundance is provided in Appendix G. A comprehensive list of plant species known to occur on Fort Hood and their abundance is provided in Appendix H.

2.1.9.1 Federally Listed Species Managed

Five threatened or endangered species occur on or in the vicinity of the installation. The endangered or threatened species (as determined by the U.S. Department of the Interior) observed at Fort Hood include the bald eagle (*Haliaeetus leucocephalus*), and the whooping crane (*Grus americana*). Whooping cranes are known to pass over Fort Hood during migration, and have been known to stop over to rest and forage. The golden-cheeked warbler (*Dendroica chrysoparia*), which was federally listed as endangered in December 1990, nests on Fort Hood from March through July. The black-capped vireo (*Vireo atricapilla*) was listed as endangered in November 1987, and it nests on Fort Hood from March through August each year.

The presence of federally listed endangered species on Fort Hood is a significant natural resource management challenge for the Army and Fort Hood. In accordance with the Endangered Species Act of 1973, the Army must assist in the recovery of all listed threatened and endangered species (TES) and their habitats under the installation's management authority. AR 200-3 requires installations to prepare an Endangered Species Management Plan (ESMP) for all listed and proposed TES. The installation ESMP should be used as a tool to achieve conservation objectives for populations of listed and proposed species while minimizing impacts on the training mission. The U.S. Fish and Wildlife Service (USFWS) Biological Opinion for Fort Hood (September 1993, as amended, and March 2005; see Appendix J) provides requirements and guidance for endangered species management on Fort Hood. The ESMP is written specifically for use by natural resource managers and leaders of training operations on Fort Hood to accomplish military training objectives while meeting conservation objectives for TES.

2.1.9.1.1 Existing TES Management

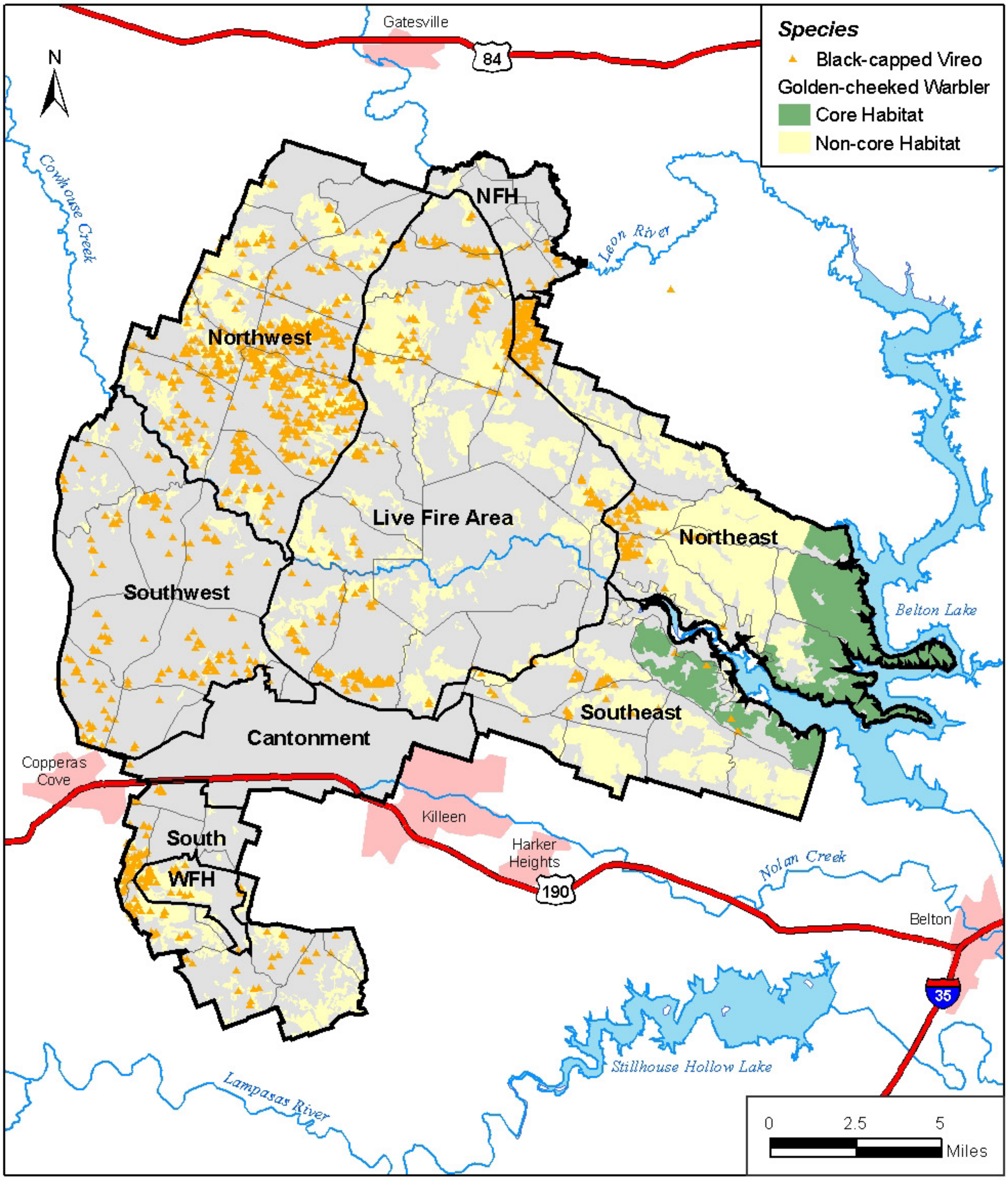
A key feature of the ESMP (FY 2001–2005) was the designation of core and non-core habitat areas (Figure 2-9), along with the modification of training restrictions and habitat protection measures based on these designations. Core habitat areas are primarily large, contiguous blocks of quality habitat where potential mission conflicts are below average and where habitat protection measures will be enhanced and active management will be performed. Non-core habitat areas are typically smaller, noncontiguous fragments of habitat in high-conflict training areas where restrictions will be relaxed to enhance training opportunities.

Fire management policy has been enhanced by the Firebreak Construction Plan, along with prescribed burning to reduce fire hazards near core habitat areas. Several mitigation studies were initiated following a major loss of habitat during a wildfire in 1996, including a study of dispersal patterns and patch utilization by warblers affected by the fire, extensive vegetation mapping and monitoring to document successional development of endangered species habitat following a disturbance, and a monitoring effort to track colonization patterns of black-capped vireos moving into new habitat created by the fire. These studies will continue and findings will be reported to USFWS and published in the scientific literature as data become available.

Cave-adapted or cave-dependent faunal communities of Texas are often represented by rare endemics due to the narrow ecological niche and natural isolation of the cave systems they inhabit. The objective of the ESMP is to provide adequate protective measures to avoid listing cave-adapted species found on Fort Hood under the Endangered Species Act (ESA). Several endemic and currently undescribed cave invertebrate species and one probable new species of salamander occur on Fort Hood. Many of these species could be proposed for listing as endangered in the future. Rare or endemic cave-adapted species known to occur on Fort Hood are listed in Appendix I.

Ongoing karst (cave) research and monitoring will be furthered by the completion of surveys, mapping, and biotic collections in known karst features. Fort Hood currently operates under its Karst Management Plan (Appendix K).

No federally endangered or threatened plant species are known to occur on Fort Hood. The Alabama croton (*Croton alabamensis* var. *alabamensis*) is a species of concern that was formerly a category 2 candidate for federal listing. This species was formerly known from only two counties in Alabama and one county in Tennessee. In 1989, a variety of *C. alabamensis* was discovered on Fort Hood.



LEGEND

Installation Boundary

Region Boundary

Training Area Boundary

Source: Fort Hood GIS, 2005.

Threatened and Endangered Species

Figure 2-9

2.1.9.1.2 Proposed TES Management

Fort Hood proposed to revise the installation's ESMP. A biological assessment (September 2004) of the effects of the actions that will be incorporated into the revised ESMP has been submitted to the USFWS, which issued a Biological Opinion on 16 March 2005. The changes to the ESMP are as follows:

- *Modification of current fire management and protection policy within the Live-Fire Areas,* as described in Section 2.1.5.

- *Reduction of habitat area designated as "core" subject to Fort Hood Endangered Species Training Guidelines.* Currently, 4,184 ha of black-capped vireo habitat and 14,879 ha of golden-cheeked warbler habitat are designated as core habitat. Training activity in habitats designated as core is subject to conditions of the Fort Hood Endangered Species Training Guidelines (see Section 2.1.2.1). These guidelines prohibit fixed activities of greater than 2 hours' duration in designated core habitats during the period 1 March through 31 August. Vehicle traffic is restricted to existing roads and trails in core habitats. Under the proposed revisions to the ESMP, the core habitat designation will be removed from all 4,184 ha of black-capped vireo habitat, and the core habitat designation for golden-cheeked warblers will be reduced to 3,861 ha (see Figure 2-9). The purpose of this proposed change is to provide installation trainers maximum flexibility and accessibility to training lands and to reduce coordination requirements for soldiers conducting field training exercises. This flexibility is required to allow the Army to adapt training operations as necessary to respond to rapidly changing mission readiness requirements and national security needs.

- *Projected habitat loss due to facility construction and maintenance activities.* Currently, construction and range improvement projects on Fort Hood that potentially eliminate endangered species habitat require individual consultations with the USFWS. Under the revisions to the ESMP, a programmatic incidental take permit was established to cover anticipated take of habitat over a 5-year period due to military construction and range improvement activities.

2.1.9.2 Designated Critical Habitat

Currently, there is no habitat on Fort Hood designated as critical habitat by the USFWS.

2.1.9.3 Areas Restricted Because of Sensitive Habitat/Open Space

Areas that are restricted because of sensitive species habitat were discussed in Section 2.1.9.1.

2.1.9.4 Ecological Reserve Areas or Resource Natural Areas

In January 2001 two urban natural areas were designated on undeveloped tracts at Fort Hood. The development of one of the tracts (as an urban natural area) is under way. The purpose of designating these sites as urban natural areas is to promote the observation, appreciation, and study of nature by providing easily accessible sites that have been preserved and enhanced to support such activities. Enhancements will be limited to those that support this purpose and may include development of a trail system, installation of interpretive signs or exhibits, and management of existing resources to promote the diversity of the area, such as development of a wildflower meadow or transplanting of native shrubs and trees. Activities that are not consistent with this purpose or are disruptive or destructive to the resources, as determined by the Fort Hood NRMB, will not be permitted.

Preservation and enhancement of these sites as urban natural areas benefits Fort Hood by

- Enhancing the quality of life for Fort Hood's families
- Providing a buffer between the Comanche I housing area and any existing or future development
- Providing easily accessible field sites for the environmental education programs of on- and off-post schools
- Providing easily accessible sites for scout and other youth group field trips
- Increasing awareness and appreciation of Fort Hood's natural resources
- Preserving and enhancing wildlife habitat in the cantonment area
- Providing a corridor for movement of wildlife among parcels of open space
- Providing a refuge for wildlife displaced by construction of the railhead or by other habitat alterations
- Providing an opportunity to further Fort Hood's positive relationship with the surrounding communities (Fort Hood, 2001b)

The Fort Hood Natural and Cultural Area (NCA) is a 125-acre plot that offers residents and visitors the chance to observe and appreciate nature and the cultural heritage of Central Texas (Figure 2-10). The area is intended to highlight the diversity of native species of plants and animals, as well as the history of the region, by providing opportunities for viewing wildflowers, deer, a beaver pond, and a historic farmstead. Walking and biking trails that are currently under development will someday allow access to various points of interest in the area. The NCA is east of Clear Creek Road between Tank Destroyer Avenue and Battalion Avenue (Fort Hood, 2004f).

2.1.9.5 Historic Landmarks

There are no historic landmarks in the training areas at Fort Hood.

2.1.10 Forest/Woodland Management

The Army forest management program is required to support and enhance the immediate and long-term military mission and to meet natural resource stewardship requirements set forth in federal laws (AR 200-3). Army policy further stipulates that forest resources must be managed for multiple uses, using an ecosystem management approach to optimize the benefits to the installation's natural resources. FORSCOM technical guidance indicates that installations should implement ecosystem management to support the military mission, while protecting endangered species and their habitat (FORSCOM, 1997). Ecosystem management provides a framework for holistic management of the resource rather than focusing emphasis on a single aspect or activity such as commercial timber production or game species management.

Fort Hood does not have a commercial timber harvest program. Juniper cutting is conducted on a limited basis to prevent encroachment into open training areas where unfettered growth could have negative impacts on training of mechanized units. Ecologically, encroaching junipers reduce regeneration of hardwood and other plants utilized by deer, as well as increase stress and reduce the long-term survival of hardwoods. Managing juniper to more desirable densities through mechanical methods, hand clearing, and prescribed fire supports survival and regeneration and sustainment of hardwood and grasses. Activities conducted to minimize or eliminate the growth and encroachment of junipers are discussed in Section 2.1.8.

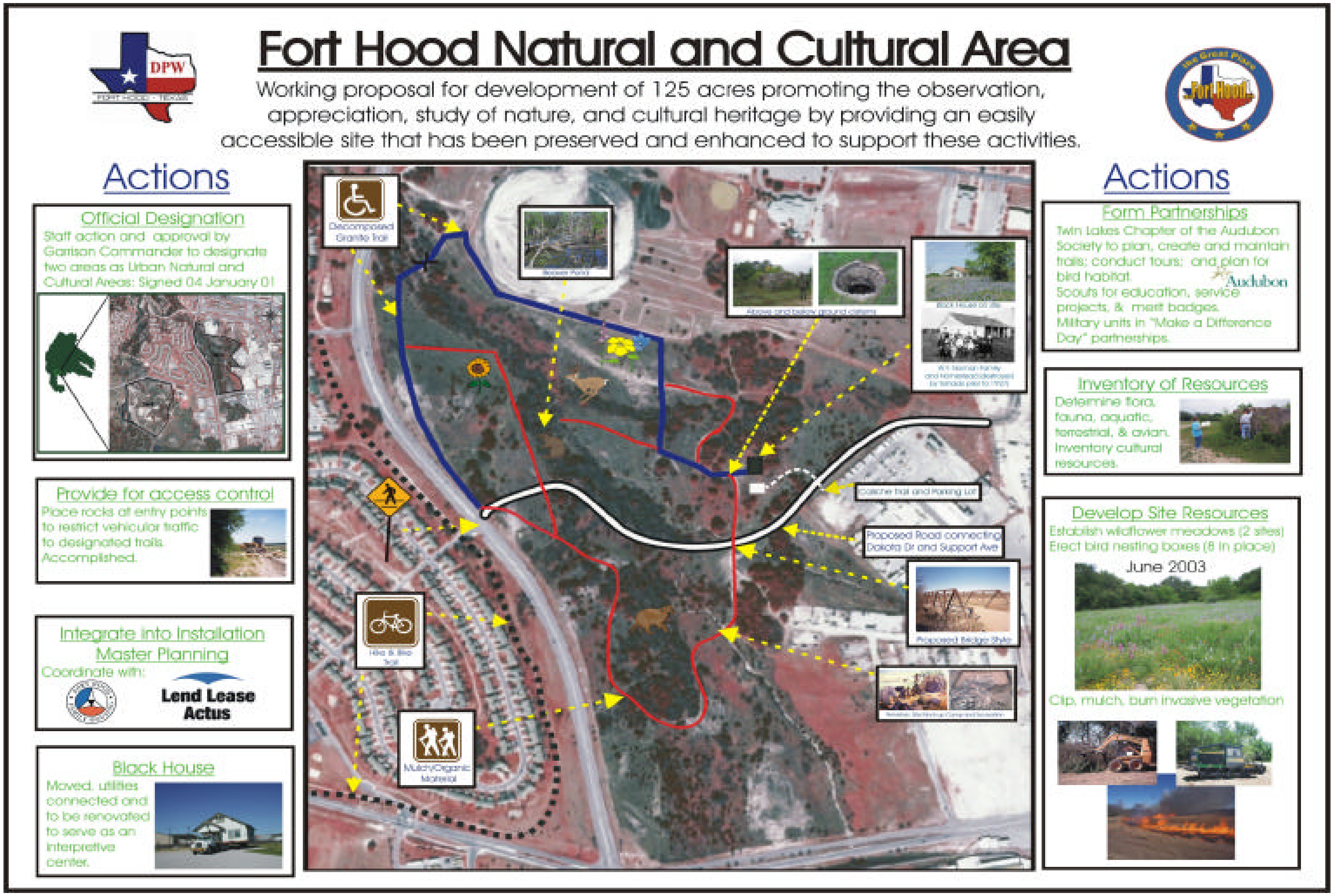


Figure 2-10. Fort Hood Natural and Cultural Area (Source: Fort Hood, 2004f.)

The primary focus of forest/woodland management activities at Fort Hood is the minimization of impacts to oaks from oak wilt, a disease caused by the fungus (*Ceratocystis fagacearum)*. The fungus is systemic, inhibiting the ability of the vascular system to move water and nutrients upward resulting in wilting of leaves, and ultimately causing the death of the tree (Fort Hood, 2004b).

Texas red oak and Plateau Liveoak are the primary carriers of the disease, which is usually spread through the root system. Oak trees grow in colonies with their roots grafted together and provide the primary means of transportation for the disease. The disease normally moves at a rate of approximately 100 feet per year. Natural boundaries such as rock layers or open spaces between oak colonies can restrict wilt spread. If all above ground plant parts are removed the root system will continue to spread the disease. Usually about 90% of the trees in a wilt center will die.

A Texas red oak which dies in late summer or early fall may develop fungal mats, which consist of an orange, sticky, jell material, that attracts sap feeding insect vectors (primarily *Nitidulids* or very small picnic beetles) (Fort Hood, 2004b). The infestation of healthy trees can occur when these beetles travel from the fungal mats with fungi spores attached to their bodies (or in its digestive track) to a fresh wound on another Texas red oak or live oak. Infestation must occur within 72 hours or before a tree wound dries. Trees of the White Oak family are not as likely to be infected, but if they are, they may take several years to die. Normally, they have more tolerance to oak wilt. Approximately 99 percent of trees are infected through the root system and one percent is the result of insect vectors.

An aggressive oak wilt management program is needed on Fort Hood to control wilt effects, although it is unlikely that the disease will ever be eliminated from the ecosystem. Painting of wounds is a method recommended in urban landscapes to prevent insect infestation, however, this is not a practical treatment in the training areas. Another practice is *trenching*, which involves digging a 4 to 5 feet deep trench about 100 feet outside of infected areas. The objective of trenching is to sever the root masses, therefore the trench can be immediately refilled. This practice controls the spread of wilt to healthy trees. Because of the size of the training lands and the need for cultural resource approval prior to trenching, implementing this management approach on a large scale is expensive and impractical.

2.1.11 Agricultural Outlease

One of the most significant natural resource management issues at Fort Hood is the leasing of training land for livestock (cattle) grazing. The installation has one outlease for cattle grazing. When Fort Hood was established by condemning private lands, the federal government granted landowners fair market value for the land and a 5-year lease for grazing. The affected landowners formed the Central Texas Cattlemen's Association (CTCA), and the lease to the CTCA has been renewed continuously since its first issuance. Fort Hood allows grazing on approximately 190,000 acres (88 percent) of its 214,778 acres (U.S. Army Audit Agency, 2001). Excluded from the leased acreage are the cantonment areas (North Fort Hood, West Fort Hood, and main), the DOL area west of the main cantonment area, and training areas 20 and 30 near the main cantonment area (Fort Hood, 2001a). Figure 2-11 shows the locations of the grazing management areas. Table 2-12 lists the major grazing management areas, the training areas each management area comprises, and the number of acres in each management area.

The Corps of Engineers, Real Estate Division, Fort Worth District, is responsible for administration of the grazing outlease at Fort Hood (U.S. Army Audit Agency, 2001). Fort Hood's Natural Resources Management Branch, part of DPW's Environmental Division, initiates the lease process.

As part of the planning process for the INRMP, the NRCS conducted a detailed inventory and evaluation of the training areas (USDA-NRCS, 2002b). The purpose of the study was to determine the general ecological health of the training areas, as well as the stocking rates of individual training areas and management areas, and to recommend changes to protect and restore the ecological health of the training areas.

Table 2-12
Grazing Management Units by Training Areas and Acreage

Grazing Management Unit	Training Areas	Leased Acres
Eastern Training Area–North	8 (partial), 10, 11, 12, 13, 21, 22, 23, LTA 115, BLORA	27,091
Eastern Training Area–South	8 (partial), 30, 31, 32, 33, 34, 35, 36	21,935
Live-Fire and Impact Area	80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94	58,150
North Fort Hood	300, 301, 302, 303, 304, 305, 306	3,793
West Fort Hood–North	200, 201, 202, 203	7,959
West Fort Hood– South	70, 71, 72, 73, 74	5,873
Western Maneuver Area–North	50, 51, 52, 53, 60, 61, 62, 63, 64, 65	32,983
Western Maneuver Area–South	40, 41, 42, 43, 44, 45, 46, 47, 48	30,399
Total		188,183

Source: Fort Hood, 2001a, 2004b.

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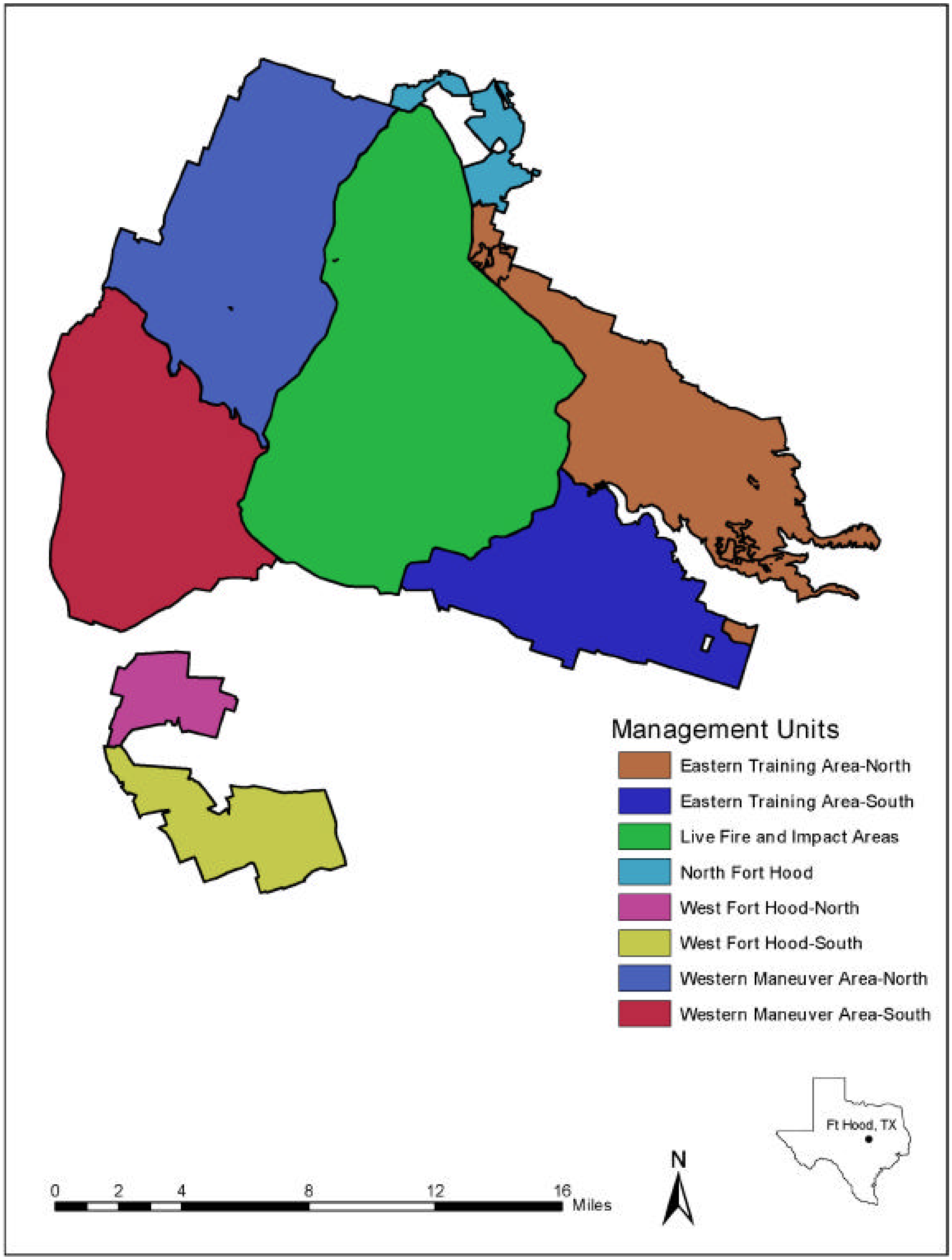

2 **Figure 2-11. Fort Hood Grazing Units.**

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The stocking rate for each lease period is the number of animal units (AU) that are allowed to graze on a particular Grazing Management Unit (GMU). Animal unit equivalents were developed to standardize AUs among the various kinds and class of bovines. Table 2-13 presents the AU equivalents used by Fort Hood.

Table 2-13
Animal Unit Equivalents

Kinds / Classes of Bovine	Animal Unit Equivalent
Cow, dry	0.92
Cow, with calf	1.00
Bull, mature	1.35
Cattle, 1 year old	0.60
Cattle, 2 years old	0.80

Source: Fort Hood, 2005.

Stocking rates are based on a stocking rate calculation methodology for each GMU based on the ecological health and trend of the unit, and the potential for soil erosion (Fort Hood, 2005). Forage will be made available for grazing to the extent practicable, while maintaining the ecological health and hydrological condition of the sites, and providing the flexibility to modify stocking rates should the ecological health, trend, or erosion at a GMU improve or decline. The stocking rate calculations methodologies are listed below (USACE, 2003; Fort Hood, 2005):

- Conservation Threshold. This approach sets a management objective of maintaining 1,000 lbs/acre of forage residue after grazing.

- Maintenance Threshold. This approach sets a management objective of maintaining 750 lbs/acre of forage residue after grazing.

- 25 Percent Harvest Efficiency. This approach is based on the premise that 50 percent of the forage on a site should be left ungrazed to provide cover for the soils and keep the vegetation healthy. The other 50 percent is made available to the grazing animal, but only half of that (25 percent of the total) is actually consumed by the animal. The other 25 percent is lost during the act of grazing by the animal and is returned to the soil as litter, trampled, or consumed by insects. Thus, only 25 percent of the forage will be consumed by livestock.

The lease area is inventoried each year in spring to determine the allowable stocking rate for the next year to keep grazing animals in balance with available forage. The forage inventory contractor makes annual recommendations to Fort Hood regarding any appropriate change in the stocking rate. The current stocking rates listed in Table 2-14 are based on the 2005 forage inventory.

Table 2-14
Stocking Rates and Calculations for each Fort Hood GMU

GMU	Stocking Rate Calculation Methodology (2004-2005)	Grazeable Acres	Animal Units
Western Maneuver Area – North	Maintenance Threshold	32,983	281
Western Maneuver Area – South	Maintenance Threshold	30,399	358
West Fort Hood – North	25% Harvest Efficiency	5,250	68
West Fort Hood – South	25% Harvest Efficiency	8,582	99
Eastern Training Area – North	25% Harvest Efficiency	27,091	175
Eastern Training Area – South	Maintenance Threshold	21,935	121
North Fort Hood	25% Harvest Efficiency	3,793	0
Live Fire and Impact Area	Limited based on Live-Fire Training Intensity	58,150	898
TOTAL		**188,183**	**2,000**

Source: Fort Hood, 2005.

2.1.11.1 Negative Aspects of Grazing

Large portions of the training areas are subject to excessive sheet and gully erosion (USDA, 1993, as cited in Fort Hood, 2001a). The resulting sediment is very detrimental to receiving streams. The poor ecological condition of training areas used for maneuver training by tracked vehicles and a historical low level of land maintenance are the primary causes of the erosion. However, an environmental assessment of the renewal of the grazing lease noted that ecological conditions at Fort Hood have worsened since the inception of the original grazing lease and that cattle grazing has the potential to contribute to poor ecological conditions. A supplemental environmental assessment (SEA) addresses these potential environmental impacts and evaluates several new alternative management actions. (Refer to the Grazing SEA for further information; USACE, 2003). A plan to address the erosion problem includes establishing a livestock rotation grazing program (Fort Hood, 2001a).

The need for an active cowbird control program is directly related to cattle grazing on Fort Hood lands. From 1997 to 1999, the CTCA operated 27 cowbird traps around the boundaries of Fort Hood. This trapping program was intended to enhance Fort Hood’s cowbird control program and mitigate the effects of continued grazing in endangered species habitat areas during the nesting season. To provide additional mitigation, TPWD adopted the Fort Hood trapping methodology and trap design, and Fort Hood personnel trained TPWD personnel. Since 1998, the State program has rapidly expanded in the Fort Hood area to include about 60 traps currently in operation by private landowners within a 10-mile radius of FH.

Between October 2001 and October 2002, the total downtime on training ranges caused by cattle was approximately 250 hours, or about 11 days (USACE, 2003). The amount of downtime was not considered to have significantly affected the installation's ability to conduct its training mission (U.S. Army Audit Agency, 2001).

2.1.11.2 Beneficial Aspects of Grazing

Fort Hood's grazing outlease program benefits the installation by maintaining good public relations, especially with the landowners of the CTCA. Grazing outlease proceeds can be used to fund many environmental stewardship programs on the installation, from maintenance of natural resources to preservation of cultural resources. During the lease period from 13 March 1996 through 12 March 2001, the value of the lease was set at $565,300. However, the U.S. Army Audit Agency estimated that the fair-market value for the 5-year lease agreement during that period had been *understated* by $918,620 (U.S. Army Audit Agency, 2001). Rather than provide payment to further environmental stewardship projects, the cattlemen provided in-kind services, such as mowing in the cantonment area, fence repair and construction, and cattle guard maintenance.

2.1.12 Outdoor Recreation

Fort Hood has a very active Outdoor Recreation Program, which has been recognized as the Army's best recreational program. The Belton Lake Outdoor Recreation Area (BLORA), the Sportsmen's Center, the Outdoor Recreation Equipment Center, and the West Fort Hood Travel Camp are components of the program. The Outdoor Recreation Program provides basic recreation opportunities (e.g., hunting, recreation lodging, swimming, camping, boating, fishing, nature trails) and other opportunities that meet more specialized interests (e.g., skiing, scuba diving, excursions, horseback riding, mountain bike riding, archery, skeet shooting).

Hunting and fishing are major recreational programs at Fort Hood. Deer and turkey hunting account for most of the hunting; quail, small game, duck, goose, dove, feral pig, and unprotected wildlife hunting are also available. Fishing opportunities abound in Belton Lake—a major recreational lake in the Central Texas area—and the small lakes, stock ponds, streams, and rivers on the installation. Live trapping is authorized on the installation, but participation is low. October is the archery season for deer, and firearms hunting occurs from November to early January. The turkey season lasts from early April to early May.

All Outdoor Recreation Branch recreational activities are coordinated with the DPW's NRMB to ensure compliance with regulations.

The following installation regulations and instructions are related to the management of hunting and fishing programs on Fort Hood. They contain all information regarding hunting and fishing on the installation, including the types of weapons that can be used, information on guided and unguided hunting, and the type of game that can be hunted.

- III Corps & FH Reg 210-25, the installation *Hunting, Fishing, and Natural Resources Conservation* regulation, establishes the policy for hunting, fishing, and natural resources conservation on the Fort Hood military reservation. Per FH Reg 210-25, firearms brought onto the reservation require registration with the Provost Marshal Office (PMO) and proof of registration (FH Form 190-X19) carried on person while hunting or transporting firearms on the installation. Proof of completion of a state-sponsored hunter education safety course is required in accordance with Texas state law. A Fort Hood fishing permit is required to fish on Fort Hood and a FH hunting permit is required to hunt.

- III Corps & FH Cir 210-YY-22, the Installation's *Hunting and Fishing Bag Limits and Seasons* regulation, is issued each September and sets hunting and fishing bag limits, possession limits, size limitations, fishing and hunting seasons, and other restrictions for sport species at Fort Hood. It establishes equipment restrictions which comply with federal and state regulations; in some instances, they are more restrictive than the federal and state regulations.

- III Corps & FH Reg 210-3, Installation's *Recreational Use of Maneuver and Live-Fire Training Areas* regulation, covers access to and use of Fort Hood maneuver and live-fire training areas for recreational purposes. It establishes III Corps and Fort Hood policy, procedures, responsibilities, and user liability related to the recreational, nonmilitary use of all Fort Hood maneuver training areas and live-fire training areas. Personnel using Fort Hood's maneuver training areas and live-fire training areas for recreational purposes must have a personal liability release form on file at the Area Access Control Center (AACC). All entry into numbered training areas for any purpose other than official military training is controlled by registering annually with the AACC and obtaining a valid FH Form 210-X9 Area Access Card upon completion of the registration process.

- III Corps & FH Reg 200-1, *Facilities Engineering Environment and Natural Resources* regulation, prescribes policies, assigns responsibilities, and establishes procedures for protection of the environment, preservation of natural resources, and hazardous material/hazardous waste management.

- DMWR *Annual Hunting Area Access and Fishing Guide* is a guidebook for hunters and anglers that contains basic information on hunting and fishing at Fort Hood and a list of prohibited activities. It contains a map of hunting areas.

2.1.12.1 Fishing Program

A valid Fort Hood fishing permit and a valid state fishing license are required for all persons 17 through 64 years old when fishing on Fort Hood. Fort Hood fishing permits are available for purchase at the AACC. All Fort Hood permits are valid for one year from 1 September to 31 August.

Fish populations in installation lakes are monitored individually, and data indicate that there is considerable variation in game fish populations throughout the year. Funds generated by selling fishing permits are used to procure catfish (*Ictalurus punctatus*) and rainbow trout (*Oncorhynchus mykiss*) to seasonally stock ponds and small lakes and to offset the operational costs of the Hunt Control Office, which conducts and promotes hunting and fishing programs on Fort Hood.

Fish are stocked seasonally (through the Put and Take Program) to provide quality fishing opportunities at lakes and ponds (Table 2-15). "Put and Take" refers to stocking (Put) legal size fish in installation waters that permitted fishers can immediately fish for and keep (Take) as a part of their creel. Largemouth bass (*Micropterus salmoides*) are stocked to maintain or establish balanced populations within a pond, particularly in newly built or renovated ponds. Supplemental stockings can be of any size, depending on the need identified, while new stockings are primarily fingerlings. Channel catfish are stocked annually in many of the installation ponds, and particularly in some of the more popular fishing lakes, to provide greater angler opportunities and to facilitate fish management by concentrating fishing pressure into specific areas. Rainbow trout were stocked annually into two installation ponds to improve winter angling opportunities. The stockings of trout comply with Executive Order (EO) 11978: The nonindigenous trout are not a threat to the Fort Hood ecosystem. Anglers catch and keep most of the fish, and the few that survive to May usually do not survive the summer water temperatures. The design of both ponds prevents escape. Forage fish, such as bluegill, redear sunfish, and fathead minnows, are stocked to supplement forage deficiencies in established ponds or to provide forage in newly constructed or renovated ponds. Stocking by sportsmen is prohibited.

Table 2-15
Fish Stocking Report

Lake	Date	Species	Length (inches)	Number	Total Pounds
Airfield	26 May 05	LMB	1.3	3100	N/A (fry)
	29 Jul 05	CCF	14.9	350	350
	29 Jul 04	CCF	15	325	325
Cantonment A	2 Jun 05	CCF	14.9	150	150
	14 Jul 05	CCF	25	10	65
	11 Aug 05	CCF	15	175	175
	24 Jun 04	CCF	14.9	370	370
	7 Jan 03	RBT	9	1,325	510
	21 Jan 03	RBT	9	1,224	400
	22 May 03	CCF	12.5	681	395
	23 Jul 03	CCF	25	25	200
	17 Dec 02	RBT	9	3,150	1,000
	9 Apr 02	LMB	15	35	100
	15 May 02	CCF	14.7	395	430
	31 Jul 02	CCF	22	40	
	15 Aug 02	CCF	12.4	656	375
Cantonment B	2 Jun 05	CCF	14.9	250	250
	14 Jul 05	CCF	25	16	104
	11 Aug 05	CCF	15	235	235
	9 Jun 04	CCF	14.9	345	345
	11 Aug 04	CCF	15	70	70
	7 Jan 03	RBT	9	1,325	510
	21 Jan 03	RBT	9	1,224	400
	22 May 03	CCF	12.5	680	395
	17 Dec 02	RBT	9	3,150	1,000
	7 Jan 02	RBT	10	1,250	500
	22 Jan 02	RBT	11	688	400
	15 May 02	CCF	14.7	394	430
	31 Jul 02	CCF	22	39	
	15 Aug 02	CCF	12.4	525	300
	18 Dec 01	RBT	10	2,800	1,000
Clear Creek Lake	18 May 05	CCF	14.9	520	495
	14 Jul 05	CCF	25	20	130
Copperas Cove #3	15 Jul 04	CCF	15	40	40
	15 Jul 04	CCF	24	16	110
	9 Jul 03	CCF	14.9	340	340
	23 Jul 03	CCF	25	25	200
	20 Jun 02	CCF	14.9	360	360
Engineer	24 Jun 05	CCF	14.9	400	400
	14 Jul 05	CCF	25	20	130
	9 Jun 04	CCF	14.9	505	505
	15 Jul 04	CCF	24	27	186
	9 Jul 03	CCF	14.9	320	320
	9 Apr 02	LMB	15	33	100

Table 2-15
Fish Stocking Report

Lake	Date	Species	Length (inches)	Number	Total Pounds
	5 Jun 02	CCF	13.6	530	405
	31 Jul 02	CCF	22	36	
Gray	7 Jan 02	RBT	10	1,250	500
	22 Jan 02	RBT	11	688	400
	15 Aug 02	CCF	12.4	132	75
	18 Dec 01	RBT	10	2,800	1,000
Heiner	18 May 05	CCF	14.9	320	320
	14 Jul 05	CCF	25	20	130
	11 Aug 05	CCF	15	415	415
	15 Jul 04	CCF	15	360	360
	15 Jul 04	CCF	24	15	103
	5 Jun 02	CCF	13.6	557	425
Larned	24 Jun 05	CCF	14.9	400	400
	24 Jun 04	CCF	14.9	365	365
	23 Jul 03	CCF	25	25	200
	19 Jul 02	CCF	10.3	893	290
Nolan	2 Jun 05	CCF	14.9	390	390
	14 Jul 05	CCF	25	42	273
	12 May 04	CCF	15.6	351	410
	11 Aug 04	CCF	15	300	300
	23 Jul 03	CCF	25	29	232
	9 Apr 02	LMB	15	32	100
	19 Jul 02	CCF	10.3	1,509	490
Table Rock Creek	26 May 05	LMB	1.3	3000	N/A
11A	26 May 05	LMB	1.3	2000	N/A
	29 Jul 04	CCF	15	50	50
	11 Oct 02	CCF	12.1	210	105
11B	26 May 05	LMB	1.3	2000	N/A
12B	26 May 05	LMB	1.3	300	N/A
22A	12 May 04	CCF	15.6	347	405
	11 Aug 04	CCF	15	360	360
	23 Jul 03	CCF	25	25	200
	20 Jun 02	CCF	14.9	290	290
	31 Jul 02	CCF	22	35	
22B	31 Jul 02	CCF	22	16	
	31 Jul 02	CCF	12.1	190	100
34A	29 Jul 04	CCF	15	370	370
	31 Jul 02	CCF	22	34	
	31 Jul 02	CCF	12.1	490	260
41B	26 May 05	LMB	1.3	2000	N/A
41F	26 May 05	LMB	1.3	2000	N/A
43C	29 Jul 05	CCF	14.9	300	300
43G	26 May 05	LMB	1.3	2700	N/A
44H	26 May 05	LMB	1.3	2700	N/A

Table 2-15
Fish Stocking Report

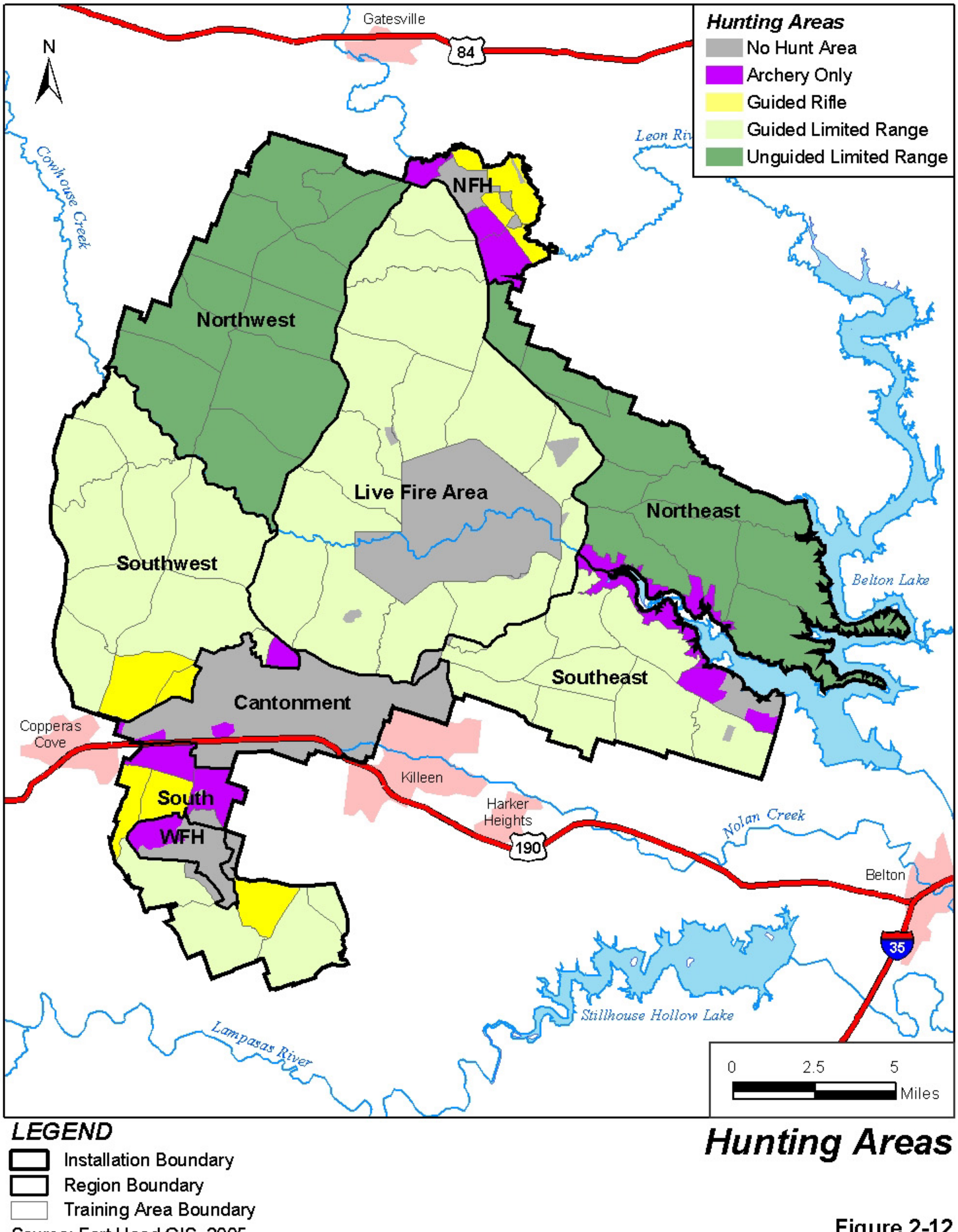
Lake	Date	Species	Length (inches)	Number	Total Pounds
45G	26 May 05	LMB	1.3	2000	N/A
45H	26 May 05	LMB	1.3	2000	N/A
46D	26 May 05	LMB	1.3	2200	N/A
51E	26 May 05	LMB	1.3	3000	N/A
306A	26 May 05	LMB	1.3	2000	N/A

2.1.12.2 Hunting and Trapping Programs

A valid Fort Hood hunting permit and a valid state hunting license are required when hunting or participating in a hunt (including the guided deer hunts) on Fort Hood. Fort Hood hunting permits are available for purchase at the AACC, building 1941. Fort Hood's hunting areas and their restrictions (e.g., guided, unguided, archery only) are provided in Figure 2-12.

Persons using Fort Hood's facilities are responsible for familiarity with the applicable statutes, regulations, and procedures for hunting safety, water safety, range entry, and proper conservation practices. Area clearances are not issued to anyone suspected of alcohol or drug consumption. The Hunt Control Office conducts approximately 10 Texas Hunter Safety Education Classes annually. Approximately 400 hunters attend these 10-hour classes each year. Per Texas law, any hunter whose birth date is on or after 2 September 1971 must attend a hunter safety course, and since September 1, 1999 per AR 210-21, any person hunting on a military installation must have attended an approved state hunting education class. Live-fire-area deer guides must attend a UXO (unexploded ordnance) Class. Participants in the fall guided rifle deer and turkey hunt programs must wear at least 400 square inches (total) of safety orange on the head and upper torso.

Categories of personnel authorized to hunt on Fort Hood are determined by rank. Category I hunters are active duty military personnel, E-5 and above, and their eligible family members. Category IA hunters are active duty military personnel, E-4 and below, and their eligible family members. Category II are retired DoD personnel, including retired military personnel (all ranks) and their eligible family members; active Department of the Army (DA) civilian personnel and their eligible family members; and appropriated- and nonappropriated-fund civilian personnel, including exchange service personnel regularly employed on Fort Hood for a minimum of 24 hours per week; and their eligible family members. This category does not include contract personnel unless they are retired military. Category III hunters are all other persons, including Fort Hood personnel working part-time (less than 24 hours per week), contractors, concessionaires, and their employees.



Source: Fort Hood GIS, 2005.

Hunting Areas

Figure 2-12

This category includes DoD civilians not regularly employed on Fort Hood. Categories establish eligibility for the permit fee structure, not priorities.

Access into all training areas for hunting and fishing is accomplished through the automated TeleTrac system. Instructions for use of the TeleTrac system are provided in the DMWR Annual Hunting Area Access and Fishing Guide. Individuals fishing in "No Check In/Out" fishing ponds and lakes are not required to check in using the TeleTrac system prior to fishing in those specific locations.

2.1.12.2.1 CHECK-IN AND CHECK-OUT PROCEDURES

All persons, 17 years of age or older, desiring to conduct any recreational activity within the Fort Hood training areas must register with the Area Access Program. The AACC issues Area Access Cards that are valid from 1 September to 31 August. All recreational users must sign in daily using the automated TeleTrac system before entering any area for recreational purposes and must sign out after departing the area.

All large game (deer and turkey) hunting is conducted by the Hunt Control Office on a controlled basis. Hunters are issued a hunting clearance on unguided hunt programs; or they are placed in a deer stand by a volunteer deer guide for each hunt area on the guided hunt programs.

Major lakes on the installation are considered free access to anglers as long as they go directly to and from the lake and have a valid Area Access Card, Fort Hood fishing permit, and state fishing license in their possession. A list of these lakes can be obtained at the AACC. If the person or guests plan to conduct any activity other than fishing, approval must be obtained from the AACC before entering the area.

Deer and turkey are the installation's primary game species. Deer are censused annually, using spotlight and incidental survey techniques IAW State protocols. The NRMB collaborates with TPWD to establish a sustainable harvest quota based on the survey data. Harvest quotas for Rio Grande turkeys are also established by NRMB. Seasons and bag limits for all game animals conform to state and federal laws and regulations and in some cases are more restrictive. All harvested game animals must be checked at the game check station. Deer and turkey harvest data are collected at the game check station and are forwarded to the TPWD.

2.1.12.2.2 POPULATION TRENDS

Deer. The deer population has remained stable in some regions on the installation but has declined in other regions. Increased military training requirements in the training areas might be a factor in the decline. Annual deer censuses and recommended annual harvest totals reflect a well-managed herd. Average deer harvest weight has continued to increase, and more mature bucks with quality racks are being harvested. The current doe-to-buck ratio is approximately 2 to 1. Hunter participation dropped in FY 1998 due to the closure of the west side training areas to conduct a 3-year study to determine whether hunting is a factor in the noted deer herd decline in those areas. Based on recent annual deer censuses and recommended harvest quotas, the deer population is expected to make small to moderate gains. Close coordination is maintained with G3 Range Control in maximizing utilization of available training areas to support hunt program requirements.

Turkey. Recently, turkey harvest numbers have reflected that the installation has had good poult hatches and that the turkey population is static to increasing. Annual turkey harvest numbers are used as a measure of poult hatch the previous year and the status of the turkey population. Hen-poult surveys are conducted via helicopter overflights to estimate population growth.

Other Species

Several of the training areas have feral pigs. Although they are not abundant currently, they are widespread and increasing, and they have the potential to become more problematic in the future should their population go unchecked. Feral pigs are a serious ecological problem because they trample vegetation, disturb soils while rooting, and compete with and prey on native species. At this time, only a few hunters participate in hunting these pigs outside the deer and turkey seasons. Fort Hood's goal is to carry out intensive effort to eradicate and prevent re-establishment of current populations.

Opportunities to hunt waterfowl on Fort Hood are numerous. There are many small lakes, stock ponds, and rivers that offer ducks a temporary refuge during their migratory flight south during the winter season and provide exceptional duck hunting opportunities. Ponds are regularly constructed to minimize erosion and collect runoff during heavy rains, and these ponds provide additional habitat for ducks.

Quail populations vary from year to year depending on environmental factors. Overutilization of bobwhite food sources and escape cover by cattle and fire ant predation play major roles in quail population dynamics.

With approximately 175,000 acres for small game hunting at Fort Hood, there is great potential for continued growth of small game hunting for squirrel, rabbit, and doves. Depending on yearly weather conditions and predator population size, small game populations can experience large fluctuations in population.

2.1.12.2.3 TRAPPING

Very few people participate in trapping on Fort Hood, though there is good potential for increased trapping. Growth will depend on market pressures and user demands based on prices for common pelts. Only live traps are authorized and the traps must be marked with the name and address of the trapper. Traps must be checked every 36 hours, and hunters/trappers of furbearing animals must possess a valid Texas Trappers License and a Fort Hood Hunting Permit.

2.1.12.3 Off-Road Vehicle Use

All recreational off-road vehicle use is prohibited on Fort Hood, with the exception of limited mountain biking in BLORA.

2.1.12.4 Nonconsumptive Recreational Activities

2.1.12.4.1 Belton Lake Outdoor Recreation Area

BLORA is a 2,032-acre major recreational and leisure area that offers a wide variety of facilities and activities to military members and their eligible dependents. Recreational activities available include RV camping, primitive tent camping, swimming, boating, fishing, and sunbathing. BLORA is equipped with party pavilions, a paddleboat dock, a boat dock, a fishing marina, nature trails, horse riding trails, mountain bike trails, waterslides, and cottages. Unit parties, family picnics, and the like can be held there. Watercraft for rent include deck boats, ski boats, fishing boats, bass boats, party boats, leisure boats, aquabikes, and jet skis. Most BLORA facilities are open to the public. Only facilities that require contracts, including watercraft rentals, camping sites, pavilion sites, and cottage rentals, are restricted to authorized users only.

There is a daily privately owned vehicle (POV) gate fee to enter BLORA, and visitors can purchase an annual vehicle pass. Additional family vehicle passes can also be purchased. BLORA honors Golden Age/Golden Access Passports by giving authorized patrons a 50 percent discount off park entrance fees (daily gate fee or annual vehicle pass fee) and a 25 percent discount off camping fees (RV pads, tent pads, or primitive camping). Persons sponsored by an authorized Golden Age/Golden Access cardholder do not receive any discounts given to the actual cardholder.

BLORA has three nature trails, totaling approximately 5 miles in length, for the nature lover. These trails are marked with signs to show the way, and rest areas are located along the paths. The trails wind through the beautiful rolling terrain at BLORA. Deer, wild turkey, and other wildlife, including the endangered golden-cheeked warbler, are frequent sights.

BLORA Ranch. Horseback and pony riding opportunities are available at BLORA Ranch, and riding lessons are available upon request. Facilities are inspected monthly by the post veterinary services to ensure proper care of the animals and clean stables.

BLORA Trailblazers Mountain Bike Course. The BLORA Trailblazers Mountain Biking Program was implemented in 1998 as a Morale Welfare and Recreation (MWR) activity to promote mountain bike riding at Fort Hood. A trail system offers approximately 14 miles of riding trails and accommodates riders at all skill and endurance levels. Riding trails at BLORA are placed in close coordination with NRMB to ensure that environmental concerns and endangered species habitat areas are fully considered. A 5-year study was conducted by NRMB and USFWS to determine the effects of mountain bike riding in endangered species habitat areas, and it could affect future decisions regarding recreational activities in endangered species habitats.

BLORA Paintball Program. A BLORA Paintball Program was implemented in May 2000 as an MWR activity to provide a safe, controlled environment whereby participants can enjoy recreational paintball. Several playing fields have been designed and established to accommodate players of all skill levels.

2.1.12.4.2 Sportsmen's Center

The Sportsmen's Center is a membership association devoted to the conservation and preservation of wildlife, their habitats, and the environment. It supports hunting, fishing, and archery, as well as recreational gun use for skeet, trap, and other target shooting. Membership is open to the public. All controlled deer and turkey hunt programs are administered by the Sportsmen's Center. A Fort Hood Hunting and Fishing Advisory Board has been established to provide the installation and Garrison Commander with an additional source of input on hunting and fishing issues, as well as to provide a forum for recreational users to suggest improvements in the use of Fort Hood’s natural resources.

The Sportsmen's Center operates three skeet ranges and two trap ranges to promote skeet and trap shooting, and an archery range to promote archery and the annual archery deer and turkey hunt programs. These facilities are open to the public.

The Sportsmen's Center has two stables to board privately owned horses. These facilities are for authorized users only. A monthly stall fee is charged per horse.

2.1.12.4.3 West Fort Hood Travel Camp

The West Fort Hood Travel Camp (WFHTC) provides 64 temporary RV camping sites, 3 large group picnic areas, and dry boat storage facilities for incoming and outgoing patrons. This facility is open year-round for authorized users only.

2.1.12.4.4 Outdoor Recreation Equipment Checkout Center

The Outdoor Recreation Equipment Checkout Center (ECOC) facility provides a wide variety of camping-related equipment to promote camping and sporting activities. Recreational items available include tents, campers, utility and travel trailers, boats and boat motors, vans, recreational games, sports equipment, camping equipment, and more. This facility is for authorized users only and is open year-round.

2.1.12.4.5 Other Recreational Activities

Boating is allowed on Fort Hood lakes and ponds, but gasoline-powered motors are prohibited. This restriction does not apply to Belton Lake, which borders the northeastern boundary of the reservation. G3 Range Division authorizes joint use of the PK Sportsmen's Firing Range for rifle and pistol shooting. Military training requirements have priority on available shooting stations at the range on a daily basis. This is the only firing range at the installation that is open to the public for the personal use of firing privately owned weapons. All weapons must be registered with the PMO before transporting them onto the installation.

2.1.13 Law Enforcement Program

The Provost Marshal is responsible for the enforcement of the laws and regulations pertaining to natural resources on Fort Hood, including enforcement of hunting, fishing, archeological, and environmental statutes and regulations. The PMO documents reports of endangered species habitat violations and works with DPW and NRMB to ensure compliance with wildlife harvest quotas, to dispose of dead wildlife resulting from motor vehicle operation, and to provide a portion of the training required for hunter safety certification. Game Wardens enforce the laws and regulations pertaining to natural resources on the installation, including those pertaining to threatened and endangered species, historical and archeological sites, fish and wildlife laws, and established harvest quotas. Game Wardens also enforce requirements related to access to the training lands and are available to provide briefings to new arrivals. There are currently eight Game Wardens on the installation.

There are two jurisdictions on Fort Hood. The original purchase areas are exclusive federal jurisdiction, and the remaining areas are concurrent federal and state jurisdiction. Activities are coordinated with state natural resources management offices.

Game Wardens annually attend in-service training with local agencies and TPWD. Wardens have at least 40 hours of refresher training annually. Newly hired enforcement officers attend full law enforcement training (11 weeks, basic training plus USFWS special training) at the Federal Law Enforcement Training Center in Georgia. Game Wardens must qualify with personal sidearms and other weapons twice annually and shotguns annually.

2.1.14 Public Land Use and Access

Fort Hood is an open installation. The maneuver training areas are open to public recreation provided those activities do not conflict with the military mission. G3/DPTM Range Division controls recreational access to all training areas and may close training areas to public recreation at any time for safety or training purposes. The live-fire training area may be accessed only after a personal visit and when authorization is received from both Range Control and the AACC. Activities that are not allowed in the training areas are described in FH Reg 210-25.

With the exception of special situations, road entrance points at installation perimeters are unmanned. A copy of FH Reg 210-3 is given to recreational users when they register at the G3 Range Division/AACC. The public is responsible for adhering to all Fort Hood regulations and restrictions placed on range access by G3 Range Division and the Army. Joint use of training areas on a daily basis is authorized as long as it does not interfere with daily military training requirements.

In accordance with FH Reg 210-25, all persons 17 years of age or older desiring to conduct any recreational activity within the Fort Hood training areas must register with the Area Access Program. The AACC issues permits that are valid for 6 months upon registration. Persons must contact the AACC for recreational access to any training area. Registration requires a person to provide picture identification, vehicle registration, and other personal information, and all persons must sign FHT Form 210-X9 Part 1, which affirms that the applicant has received the AACC briefing, understands the policies, and assumes all responsibility while in the training areas.

Entry for recreational activities into contaminated impact areas, temporary or permanent, is strictly prohibited, without exception. CTCA provides a list of its members who use the Fort Hood training areas for their livestock to the AACC. The list is validated annually and revised as necessary.

2.1.15 Invasive Species Program

Invasive species are plants and animals that invade and quickly dominate natural habitats. Invasive species are most often those imported from outside North America, such as kudzu vine (*Pueraria lobata*) or gypsy moth (*Lymantria dispar*). However, native plants that cause management problems, such as Ashe juniper, can also be considered invasive species. Noxious weeds are plant species known to be detrimental to agricultural crops, and these weeds are regulated by state and federal government agencies. There are no known noxious weeds that occur on Fort Hood, but there are several invasive plants. Invasive species of primary concern are King Ranch Bluestem (*Bothriochloa ischaemum*), broomweed (*Xanthocephalum dracuncukoides*), Ashe juniper, kudzu, and mesquite (*Prosopis glandulosa*) Fort Hood, 2001a). Feral hogs (*Sus scrofa*), fire ants (*Solenopsis invicta*), and some other insect pests could also be considered invasive species because of their foreign origin and damaging effects. Control measures for all nuisance animals and plants are covered in greater detail in the Fort Hood Pest Management Plan (Fort Hood, 2002).

The installation supports the National Strategy for Invasive Plant Management and its three goals– prevention, control, and restoration. In the event that any noxious weeds are found on the installation, a high priority for control will be established and control efforts will be maximized. A list of plants introduced to Texas is provided in Appendix D of the installation's Pest Management Plan (Fort Hood, 2002). Weeds on firing ranges, around targets, along fence lines, on road shoulders, on paved surfaces (including runways), and so forth require control using appropriate herbicides. Unwanted plants are controlled mechanically (mowing, string trimmers) or by the use of mulch materials around ornamental plants. Turf weeds such as dallisgrass (*Paspalum dilatatum*) and crabgrass (*Digitaria ciliaris*) might also require control in improved grounds. Aquatic vegetation control using herbicides is also occasionally necessary at managed fisheries ponds. Unwanted fish species are also removed from managed fisheries ponds by qualified personnel (Fort Hood, 2001a).

Prescribed fire on training lands can be used to control Ashe juniper and mesquite. Mechanical and chemical controls are also used. Noxious plant control on most of the installation except the golf course is the responsibility of the Work Services Branch of DPW. Work requests for vegetation control in the cantonment area are handled by the DPW applicators or contracted applicators as needed. The DPW Housing Maintenance/Pest Control contractor does a small amount of vegetation control, and the DPW mowing contractor occasionally uses a herbicide for chemical edging. Vegetation control projects in areas outside the cantonment area may also be done by the Work Services Branch or through the EMD/NRMB per contractor.

2.1.16 Integrated Training Area Management (ITAM)

The ITAM program is the element of the U.S. Army Sustainable Range Program (SRP) that provides Army land managers with the capabilities to manage and maintain training and testing lands by integrating mission requirements with land management practices and environmental requirements. The ITAM Program is a systemic framework for decisionmaking and management of Army training lands to avoid net loss of training land and to ensure that the lands remain viable to support future training and mission requirements.

ITAM has four components, which work in unison to accomplish the ITAM mission:

- Range and Training Land Analysis (RTLA)
- Land Rehabilitation and Maintenance (LRAM)
- Training Requirements Integration (TRI)
- Sustainable Range Awareness (SRA)

2.1.16.1 Range and Training Land Analysis.

RTLA is the component of the ITAM Program that provides for the collecting, inventorying, monitoring, managing, and analyzing of tabular and spatial data concerning land conditions on an installation. RTLA provides data needed to evaluate the capability of training lands to meet multiple use demands on a sustainable basis. It incorporates relational database and geographic information system (GIS) technologies into the land use decision process.

RTLA collects physical and biological resources data from training lands to relate land conditions to training and testing activities. These data provide the information to effectively manage land use and natural and cultural resources and supply information for a variety of decision support and information management systems such as the Army Training and Testing Area Carrying Capacity (ATTACC) model, GIS, and RTLP-AS.

The RTLA component has four main objectives:

- From baseline data, monitor natural and cultural resources, and analyze data for trends and impacts.
- Identify and recommend land rehabilitation and maintenance priorities.
- Provide GIS capabilities.

- Provide information that may affect force structure and stationing decisions.

Inherent in all of these objectives is the need to collect, manage, summarize, and interpret RTLA data to gain a better understanding of the natural resources and the relationships between mission activities and land condition. This increased understanding allows land managers to make appropriate recommendations and decisions to achieve sustainable land use.

2.1.16.2 Land Rehabilitation and Management.

LRAM is a preventive and corrective land rehabilitation and maintenance procedure that reduces the long-term impacts of training and testing on an installation. It mitigates training and testing effects by combining preventive and corrective land rehabilitation, repair, and/or maintenance practices that reduce the long-term impacts of training and testing. It includes training area redesign or reconfiguration to meet training requirements.

2.1.16.3 Training Requirements Integration.

TRI is a decision support procedure that integrates all requirements for land use with natural and cultural resources management processes. TRI integrates the installation training and testing requirements for land use derived from the RTLP, the range operations and training land management processes, and the installation training readiness requirements with the installation's natural resources conditions. The ATTACC program is the standard ITAM methodology for estimating training land carrying capacity by relating training load, land condition, and land maintenance practices. The integration of all requirements occurs through continuous consultation among the Directorate of Plans, Training, and Security (DPTS), natural and cultural resources managers, and other environmental staff members.

TRI achieves the "training-environmental" balance and interface that is key to ITAM and requires continuous interaction and coordination between the operations/training staff and the natural resources management/ environmental staff. This ensures wise land use planning and management decisions that meet regulatory compliance and training and testing activity requirements.

2.1.16.4 Sustainable Range Awareness.

The ITAM Program plays a major role in supporting the Army's training and testing mission through its commitment to environmental stewardship and training land management. SRA is the component of the ITAM Program that provides environmental stewardship training to all installation land users. It also provides a means to develop and distribute educational materials to land users. These materials relate the principles of land stewardship and the practices of reducing training or testing impacts. SRA information should assist land users in maintaining natural, usable training areas and ranges; complying with Department of the Army, Department of Defense, local, state, and national environmental laws and regulations; and, over the long term, minimizing damage to the environment to achieve minimally restricted training opportunities for future generations. Materials relate procedures for sound environmental stewardship of natural and cultural resources and reduce the potential for inflicting avoidable impacts.

The ITAM Coordinator normally performs the management functions of the SRA component of the ITAM Program. As discussed above, SRA improves land users' understanding of the impacts of their activities on the environment. The SRA program should focus on all land users, including soldiers, leaders, DA civilians, and the local community, who might use training lands for recreational purposes.

2.1.16.5 ITAM Program Integration

Fort Hood has been proactive in supporting the long-term sustainment of training lands by integrating the ITAM Program with the natural resources management program to support training requirements; land stewardship education; and training, environmental, cultural, and conservation management. The Fort Hood Land Sustainment Management Plan (LSMP) is the vehicle for the integration of natural, cultural, range master planning and infrastructure, and ITAM Program objectives (Fort Hood, 2004b).

The responsibilities for sustainment of the training lands and environmental compliance have been divided among DPTS, Range Control; Range Control, ITAM Program; DPW, Environmental Division; and DPW maintenance, repair, and upgrade programs (Fort Hood, 2004b). The Training Lands Committee has established a 25-year sustainment goal. The goals and management activities for the agencies involved have been divided into short-, mid- and long-range plans. The short-range plan involves the ITAM Program to repair and enhance land resources. The ITAM Program assists the NRMB in supporting the mid- and long-range components of the plan by repairing new maneuver land damage, minimizing erosion, reducing the backlog of training land repairs, maintaining trail networks to support future forces combat vehicles, and preparing sustainable range awareness training materials and courses for soldiers, leaders, units, and senior commanders.

A description of future ITAM strategies and activities is provided in Section 3.17.

2.1.17 Cultural Resources

2.1.17.1 Prehistoric and Historic Background

The Draft *Integrated Cultural Resource Management Plan for Fort Hood, Texas* (ICRMP) provides a description of the history of the III Corps and of Fort Hood (Fort Hood, 2001c). The *Cultural Resource Management Plan* (CRMP) *for Fort Hood, Texas, Fiscal Years 1995-1999* (HQDA, 1995a) contains a detailed description of the prehistoric and historic background for the land encompassed by the installation as well. Both documents are incorporated by reference.

2.1.17.2 Status of Cultural Resource Inventories and Section 106 Consultations

The Fort Hood Cultural Resource Manager currently has oversight responsibility for at least 218,827 acres of land at Fort Hood, comprised of approximately 213,093 acres owned by the Army, as well as 5,733 acres leased from the U.S. Army Corps of Engineers that is adjacent to Lake Belton. A total of 218,000 acres of the installation is comprised of range-land training areas, including live fire ranges and impact areas (Fort Hood, 2001c). The first intensive archaeological investigations at Fort Hood began in 1949 through the National Park Service River Basin Surveys (Fort Hood, 1999). A total of 100 percent of the Training and Cantonment Areas have since been surveyed for archaeological resources (Huckerby, personal communication, 2005), while over 70 percent of the Live Fire Area has undergone archaeological survey (Fort Hood, 2001c). The unsurveyed area in the Live Fire Area is approximately 17,710 acres. Approximately 43 percent of this unsurveyed area has not been included in systematic pedestrian cultural resource surveys due to its identity as a permanently dudded zone. The inventory of archaeological cultural resources was completed in 1991, and since that time the Fort Hood Cultural Resources department has undertaken an aggressive program of archaeological testing to assess all known archaeological sites on the installation for National Register of Historic Places (NRHP) eligibility.

NRHP eligibility assessments of historic resources at Fort Hood have focused primarily on historic document review supplemented by site visits. These assessments have been divided into two segments based on the two periods of property acquisition of the installation: the establishment of Camp Hood between 1942 and 1943, and the second acquisition between 1953 and 1955, when Camp Hood was redesignated as Fort Hood and became a permanent facility. Eligibility assessments for the prehistoric archaeological resources have primarily been accomplished through systematic shovel testing on a prioritized regimen of testing based on mission needs, especially within the training areas (Fort Hood, 2001c).

To date, more than 2,200 archaeological sites have been documented within the lands under the auspices of Fort Hood, of which approximately 1,100 have been identified as prehistoric sites and 1,119 as historic sites. Of the prehistoric sites, 174 have been determined to be NRHP-eligible, while 13 historic sites are NRHP-eligible. Additionally, approximately 274 prehistoric sites and 717 historic sites are currently considered potentially eligible for the NRHP. A total of 652 prehistoric sites have been determined to be ineligible for the NRHP, while 389 historic sites have proven to be ineligible for the NRHP (Fort Hood, 2001c; Fort Hood GIS, 2005). No archaeological sites at Fort Hood are currently listed on the NRHP. Fort Hood currently protects 1,178 archaeological resource sites (approximately 13,500 acres). With 100-meter buffer zones implemented, the total acreage for suggested avoidance is raised to 33,500 acres. Military and civilian digging is controlled in unsurveyed areas and alluvial terraces as well (Fort Hood, 2001c).

The majority of prehistoric sites at Fort Hood fall into several categories: caves/sink holes; instances of lithic scatter; middens; mounds; open hunter/gatherer camps; open camps with middens; rock art; Paluxy (hearths or burned rock concentrations within sandy deposits); rockshelters; kill sites; resource processing centers; sites of lithic resources procurement; and the Native American Medicine Wheel. The prehistoric cultural materials recovered from Fort Hood range from approximately 10,000 BP (Before Present) to 700 BP. The majority of the known historic sites are 19th and early 20th century homesteads, farms, and ranches, yet the dates of the historic resources at Fort Hood range from the 1850s through the periods of military acquisition in 1942 and 1953. Other types of historic sites present on the installation include livestock and water features, railroad features, bridge structures, garbage dumps, cemeteries, scatters of historic materials, and WWII era military sites (Fort Hood, 2001c). The majority of the known archaeological sites are located within the training areas.

Assessments of historic architectural properties for NRHP-eligibility at Fort Hood have been completed for WWII wooden structures covered under the National Programmatic Agreement between the National Council of State Historic Preservation officers, the Department of the Army, and the Advisory Council on Historic Preservation (Fort Hood, 2001c). A preliminary assessment of architectural properties pre-dating Fort Hood was accomplished in 1977. All standing structures constructed before 1942 were evaluated in 1979 by the architectural firm Bell, Klein, and Hoffman (HQDA, 1995a), and were re-evaluated by the Texas SHPO in 1990-1991 (Fort Hood, 2001c). A total of four potentially NRHP-eligible structures have been identified at Fort Hood, two of which pre-date the military installation, one of which is a WWII era structure, and one which dates to the Cold War era. These structures include two Okay Community Buildings (dating to circa 1900), Reynold's House (circa 1915), the North Fort Hood Swimming Pool (1943), and the Cold War era Killeen Base Nuclear Warhead Storage Facility. The Okay Community Buildings include the Okay Store and the Whitehead House, both located next to the Robert Gray Army Airfield. There are no historic architectural properties at Fort Hood currently listed on the NRHP.

At least 18 cemeteries have been documented within installation boundaries at Fort Hood (Fort Hood GIS, 2005). In 1943 and 1953, several large cemeteries were disinterred and the human remains were relocated to previously established cemeteries in local communities. These cemeteries have been determined to retain their status as traditional cultural properties. Smaller cemeteries with less than 50 interments were allowed to remain (Fort Hood, 2001c). Fort Hood Regulation 210-190 describes the Army's role in the upkeep and conditions for interment of the remaining cemeteries.

There are 3 federally recognized Native American tribes affiliated with the lands of the present installation; these tribes are the Comanche, Tonkawa, and Wichita tribes.

2.1.17.3 Native American Resources

There are two recognized Native American Traditional Cultural Properties (TCPs) located at Fort Hood. The Leon River Medicine Wheel has been recognized by tribal representatives and is being used for ceremonial activities. Access to the location of the Medicine Wheel is restricted to Native Americans and to Fort Hood Cultural Resource personnel for condition monitoring. The other TCP at Fort Hood is the Comanche National Indian Cemetery, established in 1991 for repatriation of remains that had been recovered since the establishment of Fort Hood. No formal assessment of Traditional Cultural Properties has been implemented for Fort Hood to date (Fort Hood, 2001c). Sixteen of these cemeteries are protected by fences and are regularly maintained by interested parties.

2.2 Regulatory and Jurisdictional Framework

The primary purpose of the Fort Hood INRMP is to conserve, maintain, and protect the natural resources to support the military mission. The NRMB must accomplish this task while ensuring compliance with all applicable environmental legislation, regulations, and guidelines.

2.2.1 Key Laws and Regulations

Pertinent Federal Laws. The preparation of this INRMP encompasses compliance with certain laws and executive orders. For an INRMP to be valid, it must comply not only with applicable natural resource laws, but also with Department of Defense directives and instructions and with Army policies.

As mentioned in Section 1.1, the preparation of this INRMP is in accordance with the provisions of the Natural Resource Management on Military Lands Act of 1960 (16 U.S.C. ' 670a *et seq.*), commonly known as the Sikes Act, as amended according to the Sikes Act Improvement Act of 1997. In addition, Section 3-11(b) of AR 200-1, *Environmental Sustainability and Stewardship* (1 August 2004) specifies Army policies and legal and other requirements, including statutes, laws, regulations, and other guidance applicable to the Army Natural Resources Management Program.

The list in Table 2-16, although not inclusive, includes most of the legal requirements with which an installation such as Fort Hood would be concerned.

Table 2-16
Federal Statutes, Laws, and Regulations Applicable to Natural Resources Management on Army Lands

Applicable Authority	Summary
National Forest Management Act of 1974, 16 U.S.C. 472A, et seq.	Directs the preparation of plans for the National Forest System to provide for multiple use and sustained yield of the products and services and to include coordination of outdoor recreation, range, timber, watershed, wildlife and fish, and wilderness; and to determine forest management systems, harvesting levels, and procedures in light of all of the preceding uses.
Archeological and Historical Preservation Act, 16 U.S.C. 469	Requires federal agencies to identify and recover data from archeological sites threatened by their actions.
Archeological Resources Protection Act, 16 U.S.C. 470aa–470ll	Requires permits and provides for civil and criminal penalties for persons disturbing archeological resources on federal and tribal land without a permit.

Table 2-16
Federal Statutes, Laws, and Regulations Applicable to Natural Resources Management on Army Lands (continued)

Applicable Authority	Summary
The Clean Water Act (33 U.S.C. 1344 *et seq*); also known as the Federal Water Pollution Control Act of 1972	Protects, restores, and enhances the quality of the nation's waters. Prohibits discharges without a permit for any actions affecting "waters of the United States," including wetlands. Established requirements that limits be determined for point sources that are consistent with state water quality standards, procedures for state issuance of water quality standards, development of guidelines to identify and evaluate the extent of nonpoint source pollution, and water quality inventory requirements, as well as development of toxic and pretreatment effluent standards. Section 404 of the amendments authorized the Corps of Engineers to issue permits for the discharge of dredged or fill material into navigable waters.
Clean Air Act, 42 U.S.C. 7401	Requires agencies to comply with state air quality standards set in State Implementation Plans.
Comprehensive Environmental Response, Compensation, and Liability Act, 42 U.S.C. 9601–9675	Requires reporting of releases and cleanup of releases of hazardous substances; also assigns liability for cleanup.
Endangered Species Act, 16 U.S.C. 1531	Requires consultation with the U.S. Fish and Wildlife Service to ensure that actions do not jeopardize threatened or endangered species or their critical habitat.
Fish and Wildlife Coordination Act	Requires consultation with the U.S. Fish and Wildlife Service on actions affecting stream modifications.
Fish and Wildlife Conservation Act, 16 U.S.C. 2901	Encourages all federal departments and agencies to use their statutory and administrative authority, to the maximum extent practicable and consistent with each agency's statutory responsibilities, to conserve and promote conservation of nongame fish and wildlife and their habitats.
Farmlands Protection Policy Act, 7 U.S.C. 4201	Establishes criteria for identifying and considering the effects of federal actions on the conversion of farmland to nonagricultural uses.
Federal Facility Compliance Act, 42 U.S.C. 6901	Requires federal facilities to comply with state and local environmental laws, as well as federal environmental laws.
Federal Land Policy and Management Act of 1976, 43 U.S.C. 1701–1784	Provides for the management of public lands that will protect the quality of scientific, scenic, historical, ecological, environmental, air and atmospheric, water resource, and archeological values that, where appropriate, will preserve and protect certain public lands in their natural condition.
Migratory Bird Treaty Act 16 U.S.C. 701–719c	Decreed that all migratory birds and their parts (including eggs, nests, and feathers) were fully protected.
The National Historic Preservation Act, 16 U.S.C. 470 *et seq.*	Requires agencies to identify historic properties subject to effect by their actions, and to consult with the State Historic Preservation Officer and others about alternatives and mitigation.

Table 2-16
Federal Statutes, Laws, and Regulations Applicable to Natural Resources Management on Army Lands (continued)

Applicable Authority	Summary
The National Environmental Policy Act, Public Law 91–190	Requires agencies to consider impacts on the human environment from proposed actions and to document environmental impacts during project planning.
Noise Control Act of 1972, Public Law 92–574	Requires the federal government to set and enforce uniform noise control standards for aircraft and airports, interstate motor carriers and railroads, workplace activities, medium- and heavy-duty trucks, motorcycles, portable air compressors, and federally assisted housing projects in noise-exposed areas. The control of environmental or community noise is left to state and local agencies.
Resource Conservation and Recovery Act of 1976, 42 U.S.C. 6901–6992k	Regulates collection, storage, transport, and disposal of hazardous and solid waste and regulates underground storage tanks.
EO 11988: Floodplain Management	Directs all federal agencies to avoid, if possible, development and other activities in the 100-year base floodplain. Where the base floodplain cannot be avoided, special considerations and studies for new facilities and structures are needed. Design and siting are to be based on scientific, engineering, and architectural studies; consideration of human life, natural processes, and cultural resources; and the planned lifespan of the project. Federal agencies are required to reduce the risk of flood loss; minimize the impact of floods on human safety, health, and welfare; and restore and preserve the natural and beneficial values served by floodplains in carrying out agency responsibility.
EO 11990: Protection of Wetlands	Directs all federal agencies to avoid, if possible, adverse effects on wetlands and to preserve and enhance the natural and beneficial values of wetlands. Each agency must avoid undertaking or assisting in wetland construction projects unless the head of the agency determines that there is no practicable alternative to such construction and that the proposed action includes measures to minimize harm.
EO 12088: Federal Compliance with Pollution Control Standards	Delegates responsibility to the head of each executive agency for ensuring that all necessary actions are taken for the prevention, control, and abatement of environmental pollution. This order gives EPA the authority to conduct reviews and inspections to monitor federal facility compliance with pollution control standards.
EO 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations	Requires each federal agency to make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations.

Table 2-16
Federal Statutes, Laws, and Regulations Applicable to Natural Resources Management on Army Lands (continued)

Applicable Authority	Summary
EO 13045: Protection of Children from Environmental Health Risks and Safety Risks	Requires each federal agency to make it a high priority to identify and assess environmental health risks and safety risks that might disproportionately affect children and ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.
EO 13175: Consultation and Coordination with Indian Tribal Governments	In formulating or implementing policies that have tribal implications, requires agencies to consult with tribal officials regarding the need for federal standards and any alternatives that would limit the scope of federal standards or otherwise preserve the prerogatives and authority of Indian tribes.

SECTION 3.0: FUTURE MANAGEMENT

3.1 FUTURE MILITARY MISSION

In October 1999 the Secretary of the Army and the Chief of Staff of the Army articulated a vision about people, readiness, and transformation of the Army to meet challenges emerging in the 21st century and the need to be able to respond more rapidly to different types of operations requiring military action. The strategic significance of land forces continues to lie not only in their ability to fight and win the Nation's wars but also in their providing options to shape the global environment to the future benefit of the United States and its allies. Change is needed for the Army to become more strategically responsive and dominant at every point on the spectrum of operations (Fort Hood, 2004a).

Fort Hood is undertaking actions that are part of that transformation process designed to create combat forces that are more responsive, deployable, agile, versatile, lethal, survivable, and sustainable. III Corps and Fort Hood propose to restructure its forces into modular brigades,[1] provide additional facilities and infrastructure, and establish three small arms ranges at Fort Hood.

3.1.1 Proposed Changes in Force Structure

Modularization of operational forces would redistribute key corps and division resources to the brigade level, producing a more "brigade-centric" Army and, through standardization, providing the Army greater flexibility in meeting operational requirements. To such ends, III Corps proposes to restructure forces at Fort Hood to create a modular Corps headquarters and to restructure forces in both the 4ID and 1CD as follows:

- Create a modular Division headquarters.
- Add a fourth heavy brigade combat team.

[1] Developing Army doctrine provides for the use of "units of employment" for command and control of operational forces and "units of action" for execution of strategic, operational, and tactical missions. Corps headquarters units of employment are known as "UEy," and division headquarters units of employment are known as "UEx." A UEy or UEx may employ one or more brigades as units of action ("UAs"). As Army doctrine continues to evolve, brigade-sized units may be variously referred to as brigades, regiments, UAs, or brigade combat teams (BCTs). This EA uses "brigades" to identify these units.

- Create a support brigade headquarters staff.
- Create an aviation brigade.
- Create a fires brigade.

Specific actions of the force restructuring process that have the potential to affect the natural resources of Fort Hood include the following:

- Heavy brigades of the 4ID and 1CD currently have three maneuver battalions, each of which consists of three companies of Abrams tanks or Bradley Fighting Vehicles (total: nine companies per brigade). Modular brigades would consist of eight companies in two battalions. Thus, the 4ID and 1CD would experience a net increase in armored or mechanized companies, growing from 27 to 32 companies per division. A modular heavy brigade of mechanized infantry would consist of six battalions: two infantry battalions (mechanized), a brigade troops battalion, an armed reconnaissance battalion, a fires battalion, and a support battalion. The projected population of each brigade would be 3,644 personnel.
- For planning purposes, and as an upper limit, III Corps and Fort Hood estimate that the 4ID and 1CD would each experience net growth of up to 4,000 personnel. The numbers of personnel in Corps-level units would most likely decrease, but the extent of the reductions cannot be known until the revised Mobilization Table of Organization and Equipment (MTOE) is finalized.
- The training of modular units would be highly similar to that of existing units. Most of the training time and effort would continue to be expended in developing and reinforcing the skills of persons in their military occupational specialties and in crew- and small-unit training. Collective training of companies and larger units would also continue; the frequency and duration of training events and requisite proficiencies would be as established in Army Training and Readiness Evaluation Program (ARTEP) directives.
- The 4ID's fourth heavy brigade combat team was manned, equipped, trained, and ready to deploy as of June 15, 2005; modularization of 1CD's fourth heavy brigade combat team began in early Fiscal Year (FY) 2006 (i.e., after 30 September 2005). Dates for modularization of other brigades have not been established.

- Three new small arms live-fire ranges have been proposed to supplement the post's current inventory of 77 live-fire ranges (Fort Hood, 2004a). These ranges would provide training for squad-designated marksmen, snipers, and machine gunners. Alternative locations for each range were examined for potential use; consideration was given to adequacy of length and width, suitability of firing positions and target locations, availability of adjacent buffer zone areas, topography, cultural sites, and wildlife habitat. Ranges at all potential locations would be oriented so that the beaten zones (where rounds would land) would be in the post's existing impact areas. The following paragraphs discuss the ranges and the proposed sites found suitable for the ranges:

    – ***Squad-designated Marksman.*** This range would have up to 10 firing lanes and provide for 25-meter zeroing (sight calibration) and firing at a distance of 200 to 500 meters. A site at the Ironhorse Scaled Range in the southern portion of TA 88 was found suitable.

    – ***Sniper Range.*** This range, encompassing more than 80 acres, would have four lanes and provide for 100-meter zeroing and firing at a distance of 1,000 to 1,700 meters. A site near Sugarloaf Multiuse Range in the southeastern portion of TA 88 was found suitable.

    – ***Multipurpose Machine Gun Range.*** This range would encompass more than 130 acres and provide for 10 firing lanes. A site at North Fort Hood in the southeastern portion of TA 80 was found suitable.

3.2 DESCRIPTION OF DESIRED FUTURE CONDITION (DFC)

The U.S. Department of Agriculture's Forest Service first developed the concept of desired future condition (DFC) in the 1970s. The concept was used in the planning process for determining the maximum production of timber that could be taken from a particular area rather than what the ecosystem could sustainably produce (Leslie et al., 1996). Over the years, the concept has evolved to include all aspects of a future ecosystem, including human organizations and needs, such as the military mission.

Ecosystem integrity has been defined as "the ability to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitat of the region" (Angermeier and Karr, 1994, as cited in Leslie et al., 1996). Systems maintaining ecological integrity have the capacity for self-repair when perturbed, and minimal external support is needed for their management. Ecosystems consisting of native species are more easily maintained, resilient to perturbation, adaptable, and productive than ecosystems that have nonnative components. Therefore, the most cost- and resource-efficient ecosystem to ensure long-term sustainability for both the natural resources and military mission requirements at Fort Hood is an ecosystem where native vegetation thrives.

Range and Training Land Analysis (RTLA) data show that the installation is divided mainly into perennial grassland (65 percent) and woodland (31 percent) community types (Tazik et al., 1992), with the remaining area composed of shrubland. Most of the grasslands (83 percent) exhibit a dense or closed vegetative cover. As a result of a long history of grazing and military activity, the installation's grasslands are dominated by Texas wintergrass (29 percent) and prairie dropseed (18 percent); little bluestem grasslands compose only 9 percent of the grassland area (Tazik, et al., 1993). Broadleaf woodlands compose about 39 percent of RTLA woodland sites and typically are dominated by oaks. Coniferous and mixed woodlands compose 61 percent and are dominated by Ashe juniper or a mixture of juniper and various oaks.

Fort Hood provides habitat for significant breeding populations of the black-capped vireo (*Vireo atricapilla*) and golden-cheeked warbler (*Dendroica chrysoparia*), two federally listed endangered avian species. In addition to these species, Fort Hood provides habitat for a variety of endemic cave-restricted fauna, as well as potential transient occurrences of listed and candidate species and other species of concern (Hayden et al., 2001).

Golden-cheeked warbler habitat includes tall, dense, mature stands of Ashe juniper and a variety of deciduous species, including Texas red oak, live oak, white shin oak, post oak, Texas white ash, cedar elm, hackberry, Arizona walnut, Plateau bigtooth maple, Escarpment cherry, and pecan (Fort Hood, 2004c; Hayden et al., 2001). This type of habitat is often found in relatively moist areas such as steep-sided canyons and slopes. Occasionally, golden-cheeked warblers are found in drier, upland juniper-oak woodlands over flat topography (Fort Hood, 2004c). Arnold, Coldren, and Fink (1996) reported that 23 ha may be the minimum threshold size of habitat in which golden-cheeks can produce young. Coldren (1998) found that golden-cheeked warblers select for habitat patches greater than 100 ha.

Black-capped vireos typically inhabit shrublands and open woodlands with a distinctive patchy structure. The shrub vegetation generally extends from the ground to about 1.8 meters (6 feet) aboveground and covers about 30 percent to 60 percent of the total area. Open grassland separates the clumps of shrubs. In the eastern portion of the black-capped vireo's range, the shrub layer is often combined with an open, sparse to moderate tree canopy. In the Edwards Plateau and Cross Timbers regions, common plants in black-capped vireo habitat include Texas red oak, shin oak, Plateau live oak, Texas mountain laurel, evergreen sumac, skunkbush sumac, flameleaf sumac, Texas redbud, Texas persimmon, honey mesquite, and agarita. Densities of Ashe junipers are usually low.

Black-capped vireo habitat at Fort Hood typically is shrubby and ephemeral with a “clumped” vegetation structure. This habitat is fire-dependent; on Fort Hood, most habitat patches are maintained by prescribed fire or wildfires, or by mechanical disturbance related to military training and operations. Vireos generally occupy the site for 4 to 25 years following disturbance. The most common tree/shrub species found in black-capped vireo habitat on Fort Hood are shin oak, flameleaf sumac, Ashe juniper, Texas red oak, skunkbush sumac, Texas redbud, and Texas white ash (Tazik et al., 1993). Additional research suggests that tree/shrub species composition on vireo territories is variable and that habitat structure (i.e., the presence of low hardwood scrub) is a more critical factor in habitat selection than species composition (Tazik et al., 1993).

Training Needs. As presented in Section 3.1.1, training needs by heavy mechanized units are expected to increase at Fort Hood. Past heavy use from training and other uses (e.g., cattle grazing) has left some of the installation’s training lands severely compacted and void of perennial vegetation in many areas, causing the development of numerous gullies (Fort Hood, 2004b). These gullies affect training by causing time delays in movement, restricting maneuver training lanes, and limiting access routes through lanes during training exercises. The gullies are safety hazards to soldiers, increase the likelihood of equipment damage and repair costs, and divert resources (time and money) away from training. To address these needs, the Fort Hood Land Sustainment Management Program (LSMP) has identified the following objectives for improving the training landscape and creating the requisite conditions for the long-term sustainability of the training lands:

- Improving the training landscape
- Enhancing readiness training capabilities
- Reducing training obstacles in the primary heavy maneuver training lanes
- Reducing soil erosion rates
- Improving vegetative cover
- Providing an environment that will remain viable to support current and future maneuver and readiness training
- Improving water quality both on and off the installation

Tank crashed into 5-foot gully

Tank slipped into gully

Interrupted training, personnel injuries, and damaged vehicles can increase training costs.

Inherent in ensuring the long-term sustainability of the training lands is compliance with all federal laws and regulations, particularly the Endangered Species Act. Fort Hood is required, and has agreed, to maintain the quantity and quality of habitat necessary to protect the breeding populations of black-capped vireos and golden-cheeked warblers. In addition to avian species, the Fort Hood NRMB manages karst habitats containing endemic cave-dwelling species. Continuing research efforts are resulting in the discovery and documentation of additional caves throughout the installation. The NRMB is implementing measures to ensure the protection of these caves and the rare species that inhabit them.

The objectives of the Desired Future Conditions (DFC) of Fort Hood are to provide the conditions necessary to meet the expected increase in training, ensure the long-term sustainability of the training lands, and provide protection for sensitive and federally protected species. Maintaining the ecological integrity of the landscape is the most resource-efficient management approach to meet these objectives. The DFCs developed for Fort Hood are described below:

- Native vegetative cover sufficient to minimize erosion. In areas where grazing is allowed, maintain at least 1,500 lb/ac of consumable native perennial forage residue, preferably perennial grasses, after grazing to avoid significant impacts from training, ensure the ecological health of the training areas, minimize erosion, and protect water resources.

- Habitat area sufficient to meet U.S. Fish and Wildlife Service (USFWS) regional recovery goals for black-capped vireos and golden-cheeked warblers. Currently, these goals are as follows:

Black-capped vireo:	1,000 territorial males
Golden-cheeked warbler:	2,000 territorial males

- No net loss of populations of black-capped vireos and golden-cheeked warblers over time in the greater Fort Hood area.
- Forested riparian areas to buffer water resources from upland disturbances.
- An average of no greater than 5 percent of bare ground on all training grounds.
- Approximately 120,000 acres of open area so as not to impede mechanized training and to provide sufficient open space to accommodate all necessary DZs, LZs and forward area refueling points (FARPs). Open space and woodland should be interspersed in a natural mosaic.
- Approximately 80,000 acres of woody vegetation to enhance infantry and dismounted training on hill terrains.
- Maintenance of hydrologic regimes and erosion rates that approximate natural rates for this area to minimize sediment transport from training lands into water bodies.
- High ecological integrity of terrestrial and aquatic habitat to support balanced and diverse populations of native fish and wildlife.
- Maintenance of native species richness and evenness over time.
- Populations of indicator/keystone species, listed species, and species of concern that are viable, stable, and not declining.
- Maintenance of Belton Lake capacity adequate to meet future water quantity and quality needs, achieved by minimizing sediment transport and deposition to the lake.
- Compliance with all water quality criteria and standards for water bodies on the installation.
- Negligible effect on the ecosystem from the presence of invasive and exotic species.
- Outside-the-fence land uses compatible with the military mission and with the expansion of black-capped vireo and golden-cheeked warbler populations off-post.

- Fire return intervals between 2 and 5 years for native grassland vegetation and between 4 and 10 years for shrublands, which are managed for black-capped vireo habitat. Areas maintained as firebreaks are burned on a 1- to 2-year return interval.

- Rate of brown-headed cowbird annual parasitism of black-capped vireo nests maintained below 10 percent (averaged over 5-year periods) regardless of the cattle stocking rate.

- Reduction in the amount of pesticides being applied by validating all requests for pesticide treatments and providing education on alternative integrated pest management (IPM) procedures using biological methods, products low in toxicity, or nontoxic means of control on targeted pests.

3.3 FACILITIES AND DEVELOPED AREAS

Developed areas on Fort Hood are managed in accordance with various plans and regulations. III Corps and Fort Hood Regulation 200-1, *Environment and Natural Resources*, addresses hazardous waste management, solid waste management, air pollution control, pesticide management, spill prevention and control, and pollution prevention. Fort Hood has prepared individual management plans to address specific resource or program management activities such as hazardous waste management, pest management, spill control and cleanup, and recycling. Cantonment areas are developed in accordance with the Fort Hood Master Plan and DoD programs such as the Residential Communities Initiative, Privatization of Army Lodging, and Utilities Privatization.

3.3.1 Installation Restoration Sites

Active Installation Restoration Program (IRP) sites must continue to be managed in accordance with applicable regulations, and closed or "No Further Action" sites must be monitored where necessary to ensure that they remain innocuous. Because sites may be reentered into the IRP Environmental Restoration Program if future conditions or new information suggests it is necessary, Fort Hood should ensure that all information collected during remedial response and stored in site files is properly maintained and safeguarded. Actions regarding the site may occur years after the data has been gathered. Records should be sufficiently detailed and protected to provide a complete and accurate history of the remedial response in support of any future legal action and to aid the installation or MACOM in answering inquiries from Congress or requests from the public under the Freedom of Information Act.

3.3.2 Goals and Objectives

General goals and objectives for the facilities and developed areas at Fort Hood are listed in Table 3-1 and discussed below.

Table 3-1
Goals and Objectives for Facilities and Developed Areas

Goals	Objectives
Manage all existing and potential sources of environmental contamination to prevent releases of contamination.	Comply with all laws, regulations, and policies applicable to sources of environmental contaminants.
	Thoroughly train all employees (and ensure that all hired contractors are thoroughly trained) in the laws, regulations, policies, and procedures of handling potential environmental contaminants and preventing pollution.
Prevent environmental contamination from occurring.	Follow all protocols in relevant Fort Hood management programs to minimize the possibility of environmental contamination.
	Report all activities with the potential to create environmental contamination immediately upon their occurrence
	Initiate appropriate response actions as soon as possible after a potential contamination occurrence.
	Monitor closed and NFA IRP sites where the potential for migration of environmental contaminants exists to ensure that any release of contamination from such sites is contained and corrected as quickly as possible.
Ensure the integrity of information related to environmental response actions.	Maintain thorough records of all staff training and compliance activities.
	Maintain all data related to IRP sites and cleanup activities to remain up-to-date.
	Store at least one copy of the most up-to-date environmental program compliance data, including IRP data, in a location remote from where original records are stored.

3.4 VEGETATION MANAGEMENT

Army Regulation (AR) 200-3 requires that Army habitat management efforts be accomplished in a manner that conserves and enhances existing flora and fauna consistent with the Army's goal to conserve, protect, and sustain biological diversity while supporting the accomplishment of the military mission. To meet this requirement, activities will be directed toward the maintenance of healthy ecosystems and restoration of degraded ecosystems. AR 200-3 also requires that primary consideration be given to the management of indigenous listed, proposed, and candidate species' habitats, as well as to other environmentally sensitive areas and areas of special concern.

3.4.1 Goals and Objectives

The primary goals of vegetation management at Fort Hood are to restore and maintain native plant communities through the use of integrated ecosystem management principles while accommodating military training needs. Goals and objectives for vegetation management at Fort Hood are provided in Table 3-2 and discussed below.

Table 3-2

Goals and Objectives for Vegetation Management

Goals	Objectives
Restore and maintain native plant communities through the use of integrated ecosystem management principles while accommodating military training needs.	Increase growth and density of native vegetation, particularly in open-area habitats to enhance training.
	Eliminate nonnative species to the extent practical and feasible. Consider the occasional use of NRMB-approved annuals or other nonpersistent species for rapid stabilization of bare areas.
	Improve habitat quality for native species to the extent practical and feasible.
Control damage to vegetation from overuse by cattle.	Manage cattle grazing on training lands.
	Implement cattle grazing deferments on a rotational basis to allow revegetation of degraded training areas and riparian buffer zones, and to minimize future erosion.
	Maintain grazing deferment for a time period sufficient to allow revegetation of deep-rooted species and improve long-term sustainability of training lands.
Reduce damage to vegetation from training.	Monitor and evaluate plant responses to maneuver training.
	Install an improved training area access road (tank trail) system.
	The access road/trail system will consist of 150 miles of improved access roads, thereby allowing military units access to training lands in a manner that is less damaging to military equipment and to natural resources.

Table 3-2
Goals and Objectives for Vegetation Management (continued)

Goals	Objectives
	Harden approximately 30 hillside access points to enable safe access to hilltops and reduce soil erosion gullies. Use existing roads and openings to the maximum extent possible.
	Establish riparian buffer zones that limit vehicle traffic and digging activities that could cause soil disturbance and direct deposition of silt into adjacent stream channels.
	Use natural materials, such as large rock, cut brush windrows, and cedar hedgerows as natural “fences” to discourage traffic and grazing through sensitive areas such as highly erodible slopes or riparian zones.
Establish and maintain perennial vegetation on critical and potentially eroding areas.	Conduct annual survey to identify eroded areas on training lands.
	Identify areas of severe sheet, rill, and gully erosion that require measures other than normal seedbed preparation to establish perennial vegetation. These areas will be defined as “critical areas.” It is estimated that in excess of 5,000 acres could be defined as “critical areas.”
	Identify other areas having near-term potential for becoming severely eroded if a cover of perennial grass is not established. These areas will be defined as “potential critical areas.” It is estimated that in excess of 20,000 acres could be identified in this category.
	Repair 1,000 acres of critical areas and 4,000 acres of potential critical areas per year. Measures normally include grading, filling, and shaping prior to seedbed preparation, followed by seeding of native species, grazing deferment, and training deferment.
	Continue to provide aerial support for vegetation surveys.
Work with universities, state agencies, federal agencies, and non-governmental organizations to gather basic data on natural resources; develop planning and evaluation tools.	Continue to coordinate with universities and state, federal, and non-governmental agencies on ongoing and new research projects to broaden informational database of natural resources on Fort Hood.
	Update existing floristic inventory document as additional plant species are found.
	Develop geographic information system (GIS) database to facilitate planning, implementation, and post-implementation evaluation of projects.

Table 3-2
Goals and Objectives for Vegetation Management (continued)

Goals	Objectives
	Conduct ongoing RTLAs in cooperation with Natural Resources Conservation Service (NRCS).
	Continue to require the use of native landscaping plants around housing and buildings in cantonment areas, per MOI, *Landscaping on Fort Hood* (10 May 2004)
	Develop an installation-wide wetlands delineation, Increase wetlands management activities and use GIS to track wetlands and other environmentally sensitive areas.

3.4.2 Monitoring

Annual forage inventories should continue to be conducted to ensure that overuse of the training lands does not occur. In addition, the Grazing Management Plan currently under development should include monitoring measures for rangeland vegetation. The RTLA program will continue to monitor training land conditions under the ITAM program.

3.4.3 Other Management Alternatives Considered

A higher-intensity approach to vegetation management, in which management techniques similar to those described above would be implemented on a larger scale, was considered. Under this alternative, the acreage of training lands defined as critical areas and potential critical areas would be increased and more of these areas would be repaired and revegetated annually. Moreover, additional training lands would be included in the Training Out Area Program and tighter restrictions on cattle grazing would be implemented. However, such an increase in the intensity of vegetation management would have an adverse effect on the area of land available for training. This adverse effect would become increasingly evident with the increase of troops stationed at Fort Hood and the subsequent increase in OPTEMPO and the demands on training lands. As a result of the adverse effects on training, this alternative was eliminated from further consideration.

Under a lower-intensity management approach, fewer steps would be taken to manage vegetation. For example, the area of land in the Training Out Area Program would be decreased or the program would be eliminated completely. The effort and resources expended to identify and repair degraded lands would be decreased. This alternative would quickly result in the degradation of the training lands, proving detrimental to the military mission. In addition, increased erosion and sedimentation would adversely affect water resources, aquatic habitat and biological communities, overall biodiversity, and karst habitats and the sensitive species that inhabit them. A lower intensity of management would also subvert Fort Hood's goal of environmental sustainability of its training lands. Thus, lower-intensity vegetation management was eliminated from further consideration.

3.5 SOIL CONSERVATION/EROSION CONTROL

Soil erosion is a major problem at Fort Hood and has resulted in impaired training and degradation of the water resources. It also represents a threat to the long-term sustainability of the training lands. Impacts from training and overuse of the training lands by cattle have reduced, and in some cases eliminated, the vegetative cover, and an expansive network of gullies has developed across the installation but primarily in the western maneuver area. Observations indicate that detrimental impacts on water quality and on aquatic habitat and biota are also occurring. An example is the significant sedimentation that has occurred in Cowhouse Creek (Figure 3-1).

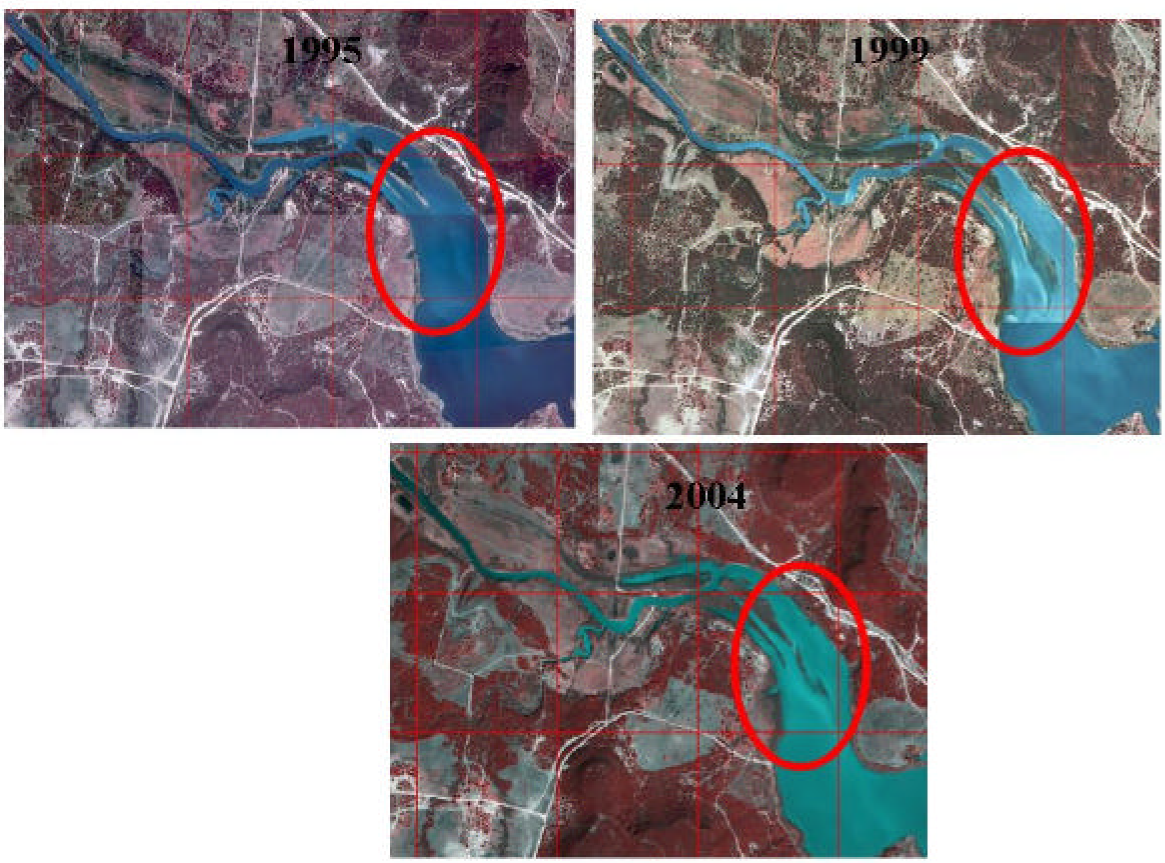


Figure 3-1. Sedimentation of Cowhouse Creek. (Source: Eckrich, 2005.)

3.5.1 Goals and Objectives

The primary goals of soil conservation and erosion control management on Fort Hood are to identify eroded soils, protect soil resources, and prevent soil erosion and its potential impacts on water quality, habitat, and mission objectives. Approximately 87 percent of the soil series that occur on the installation are considered highly or potentially highly erodible. Most of the problems associated with soil erosion on the installation occur in areas where vegetation has been removed or disturbed on steep slopes or on long, moderately steep slopes.

The objective of soil conservation and management on Fort Hood is to avoid disturbance of soils that are considered moderately or severely susceptible to erosion. Where these areas are disturbed, as a result of anthropogenic activities or natural causes, they will be stabilized and repaired in a timely manner to avoid the development of excessively eroded sites. Installation sources of erosion and sedimentation, runoff, and dust will also be controlled to prevent damage to land, water resources, equipment, and facilities on the installation and adjacent properties.

Specific goals and objectives to protect soil resources are listed in Table 3-3 and discussed below.

Table 3-3
Goals and Objectives for Soil Conservation/Erosion Control

Goals	Objectives
Protect soil resources and prevent soil erosion and its potential impacts on water quality, habitat, and the military mission.	Minimize erosion, reduce the sediment load to streams and other water bodies, protect fertile soils, and revegetate bare ground with native species.
Continue reduction of sheet, rill, and gully erosion to acceptable limits.	Continue use of the Revised Universal Soil Loss Equation (RUSLE) model to estimate soil erosion and use of soil tolerance levels and other factors to determine acceptable limits.
	Continue to develop a standardized, coordinated system for recording and mapping significant erosion damage and gully sites.
	Investigate the use of pavers to reduce runoff in improved areas, such as parking lots, staging areas, firing points and range travel lanes, and other areas subject to heavy traffic.
	Continue to provide aerial support for erosion surveys.
Continue to minimize, where possible, impacts from vehicle training maneuvers that increase soil erosion.	Maximize vehicle flow traffic on established trails.
	Limit cross-country non-tactical traffic.
	Conduct maintenance activities following training exercises to the maximum extent possible.
	Harden high-use staging areas.

Table 3-3

Goals and Objectives for Soil Conservation/Erosion Control (continued)

Goals	Objectives
	Design criteria and specifications for wet- and low-maintenance conditions.
	Close or repair trails with significant erosion problems.
Conduct erosion and sedimentation inventory and monitoring.	Continue ITAM monitoring of RTLA sites and forage inventory being conducted by NRMB to estimate soil erosion rates.
	Evaluate and prioritize a list of active erosion sites.
Minimize erosion and degradation of training lands resulting from overuse by cattle	Manage cattle grazing on training lands.
	Implement cattle grazing deferments on a rotational basis to allow revegetation of degraded training areas and minimize future erosion, as needed.
	Maintain grazing deferments for a period sufficient to allow revegetation of deep-rooted native species and improve long-term sustainability of training lands.
Maintain, and where possible, increase vegetative cover on training lands to reduce soil erosion and facilitate maintenance, restoration, and revegetation in training areas.	Increase growth and density of native vegetation, particularly in open-area habitats, to enhance training. Consider the occasional use of NRMB-approved annuals or other nonpersistent species for rapid stabilization of bare areas.
	Supply organic matter and nutrients through the addition of dairy compost, mulch or other organic biodegradable material to enhance soil quality and promote vegetative growth to reduce soil erosion where practical and in keeping with overall NRMB land management goals.
	Develop guidelines for the application of dairy compost to training lands. Dairy compost must be applied under Fort Hood NRMB supervision to protect against contamination of other resources.
	Determine methods for protecting against the potential introduction of exotic plant species and degradation of water resources resulting from the application of dairy compost to training lands.
	Encourage the use of installation-generated organic matter (e.g., grass clippings, landscape trimmings, leaves, mulch, wood chips) for application to training lands to enhance soil quality and promote vegetative growth.
	Continue forage inventory monitoring at transects and RTLA site monitoring to estimate changes in biomass, ground cover, and erosion rates.
	Continue prescribed burning to help restore and maintain the ecological health of the soils.
Continue to implement designation Free excavation site and restrictions for military training.	Continue to establish permanent excavation sites as needed.

Table 3-3

Goals and Objectives for Soil Conservation/Erosion Control (continued)

Goals	Objectives
	Continue to restrict excavation sites within 50 meters of trails, streams, and woody vegetation.
Develop and implement a comprehensive plan on the management of borrow sites.	Prohibit the use of non-permitted and unregulated borrow sites, and develop a program for rehabilitating / reclaiming borrow areas.
	Encourage the reuse of construction “spoil” material.
	Eliminate illegal dumping sites to include construction/deconstruction materials.
Continue to implement existing best management practices, assess their effectiveness, and continue to search for new BMPS applicable to Fort Hood.	Continue to implement the following BMPs to minimize erosion, conserve soil resources and protect vegetation. • Critical Area Planting (NRCS Code 342) • Early Successional Habitat Development/Management (NRCS Code 647) • Fences (NRCS Code 382) • Grazing Land Mechanical Treatment (NRCS Code 548) • Heavy Use Area Protection (NRCS Code 561) • Land Reconstruction, Currently Mined Land (NRCS Code 544) • Mulching (NRCS Code 484) • Prescribed Burning (NRCS Code 338) • Prescribed Grazing (NRCS Code 528 and 528A) • Prescribed Grazing (Appendix 1): Acceptable Grazing Use on Rangeland, Native Pasture, Grazed Forestland, Grazed Wildlifeland and Pastureland (NRCS Code 528) • Prescribed Grazing (Appendix 2): Resting or Deferring Grazing Land for a Prescribed Period (NRCS Code 528) • Restoration and Management of Declining Habitats (NRCS Code 643) • Rock Barriers (NRCS Code 555) • Sediment Basins (NRCS Code 350) • Stream Crossings (NRCS Code 578) • Use Exclusion (NRCS Code 472) • Water and Sediment Control Basins (NRCS Code 638) • Wetland Wildlife Habitat Management (NRCS Code 644) • Wetland Wildlife Habitat Management, Texas Supplement (NRCS Code 644)
	Assess effectiveness of rangeland ripping and seeding.
	Monitor effectiveness of hardened stream crossings, and continue to construct new ones as appropriate.
	Monitor effectiveness of diversion terraces and grassed waterways, and continue to construct new ones as necessary.
	Monitor effectiveness of hardened hillside access points, and continue to construct new ones as appropriate. Use existing roads and openings to the maximum extent possible.
	Monitor effectiveness of riparian zone buffers and continue to designate new ones as appropriate.

Table 3-3
Goals and Objectives for Soil Conservation/Erosion Control (continued)

Goals	Objectives
	Continue to establish rotation schedules for training and closing training areas for recovery in the Training Out Area Program.

3.5.2 Monitoring

Most of the current or planned projects detailed in the LSMP are designed to address problems resulting from erosion on training areas. Because of the potential for erosion of disturbed areas on Fort Hood, it is necessary that a comprehensive soil resource management approach be followed. The current policy of addressing problem erosion areas as they occur through the LSMP program will be continued. In addition, a management approach designed to avoid the disturbance of potential problem erosion areas will be implemented, when possible, in a manner consistent with mission objectives.

A comprehensive monitoring program involving both the NRMB and the ITAM program has been incorporated into the objectives to ensure the effectiveness of the soil conservation and erosion control measures that will be implemented as part of this INRMP.

3.5.3 Other Management Alternatives Considered

Intensive management measures are proposed for the soil resources on Fort Hood. Other soil management alternatives that represented a program consisting of fewer, and less intensive, management measures were considered but rejected. The other management alternatives considered represented the minimum approach to achieving a soil resource management program that could comply with the guidelines established in AR 200-3. The management alternatives in the minimum approach were aimed at controlling or reacting to the level of erosion, soil loss, and disturbance that could occur, rather than taking the proactive steps necessary to prevent, to the maximum extent practicable, the likelihood of such events occurring.

Given that nearly 87 percent of the soils on Fort Hood are vulnerable to erosion, this minimal approach to soil management has been rejected. The intensive use of tracked and wheeled vehicles requires continuous vegetative cover, and the ability to sustain this cover over the long term could be jeopardized by a minimal management approach and unexpected climatological events (e.g., heavy rains). The effort and resources necessary to implement the proposed approach are a prudent investment toward ensuring the long-term sustainability of the soil resources.

3.6 WATER RESOURCES MANAGEMENT

The ecological and human health importance of maintaining healthy water bodies at Fort Hood is reinforced by several federal and state laws and regulations. In addition, AR 200-1 (*Environmental Protection and Enhancement*) and AR 200-3 also promote the importance of maintaining healthy water resource systems on the installation.

Protecting and improving the water quality in the streams, lakes, and ponds is especially important because there are two large reservoirs—Belton Lake and Stillhouse Hollow Lake—directly downstream of the installation. Both reservoirs are used for municipal water supply for Fort Hood and surrounding communities, in addition to other uses. The water that drains from the installation has the potential to affect water quality at both of these locations, and it is important to maintain high quality so this water is potable. In addition, maintaining high water quality is important to preserve the ecological integrity of the water resources in and around Fort Hood. Water of a quality unable to support a diverse and healthy population of aquatic life would have an adverse effect on all local species.

Another water quality issue involves the streams flowing out of the impact areas, specifically in the Cowhouse Creek drainage basin. The water bodies exiting the impact areas have been tested for metals and explosives, but studies are limited.

3.6.1 Goals and Objectives

The primary goal of water resources management at Fort Hood is to identify and restore degraded aquatic habitats, protect aquatic and riparian habitats, and prevent degradation of water quality. Fort Hood's goals and objectives for surface water and groundwater are presented in Table 3-4 and described below.

Table 3-4

Goals and Objectives for Water Resources

Goals	Objectives
Surface Water	
Identify and restore degraded aquatic habitats, protect aquatic and riparian habitats, and prevent degradation of water quality.	Design and implement a comprehensive sampling and assessment plan.
	Expand the current water quality monitoring program to include regular monitoring of surface water and groundwater across the installation.
	Identify areas of high erosion and sediment input through stream and watershed assessments.
	Develop a database to assess status and trends in water quality and habitat suitability.
	Repair and maintain aquatic resource infrastructure such as dams and spillways to maintain safety and established aquatic habitat.
Reduce erosion and sedimentation in water resources.	Continue evaluation of effectiveness of existing BMPs to reduce sedimention and erosion of streams and assess possibilities of new ones.
	Establish and maintain sufficient vegetative buffers (stream bank and shoreline vegetation) around water bodies to minimize the flow of nonpoint source pollution, particularly sediment, into the streams.
	Limit activities within the buffer zone to those causing little or no impact on water quality and aquatic habitats.
	Continue revegetation of disturbed lands.
Continue environmental awareness and outreach programs.	Develop Sustainable Range Awareness (SRA) materials to disseminate information to soldiers and commanders.
Groundwater	
Protect groundwater resources and prevent degradation of water quality.	Develop an inventory and characterization of karst conditions and groundwater hydrologic flow characteristics on Fort Hood.
	Establish and maintain vegetated buffers around sinkholes and other karst features that provide direct access to the groundwater aquifers on Fort Hood.
	Limit application of pesticides, fertilizers, or other chemicals in or near sinkholes or other karst features.
	Locate refueling activities and other training activities with the potential for generating pollutants away from sinkholes or other karst features.
	Continue to develop and disseminate information on proper spill prevention and control techniques to be implemented in karst areas.
	Develop adequate understanding of hydrologic environment sufficient to determine wells or springs to be quarantined if spills occur in karst areas.

3.6.2 Monitoring

To gain a thorough understanding of the current state of water resources at Fort Hood and identify water quality issues, it is necessary to have a comprehensive water monitoring program. Ideally, the program should include routine water and sediment sampling across the installation, in addition to assessments of the stream habitat and biological communities. Information and data from such a program would help to characterize the condition of Fort Hood streams and the associated aquatic life, and to identify water quality issues.

Given the types and quantity of ordnance deposited in the impact area over the past several decades, continued monitoring is needed to provide additional information on potential water quality, drinking water, and other environmental concerns. This is of particular importance given that these streams drain into local municipal water sources.

The management objectives described above are designed to characterize existing conditions, determine whether there are significant water quality issues, and provide a foundational database from which to evaluate and monitor the status and trends of water quality conditions at Fort Hood.

3.6.3 Other Management Alternatives Considered

A less intensive approach to water resource management was considered but rejected. The Clean Water Act has severe regulatory implications for noncompliance that could adversely affect the ability of Fort Hood to support its mission. In addition, potential liability is associated with not knowing the conditions of water from which people catch and eat fish and drink. These conditions warrant implementing the intensive water monitoring program described in this INRMP to characterize the water resources.

3.7 WETLAND MANAGEMENT

Wetlands are of critical importance to the protection and maintenance of living resources because they provide essential breeding, spawning, nesting, and wintering habitats for many fish and wildlife species. Wetlands also enhance the quality of surface waters by impeding the erosive forces of moving water, trapping waterborne sediment and associated pollutants, maintaining baseflow to surface waters through the gradual release of stored floodwaters and groundwater, and providing a natural means of flood control and storm damage protection through the absorption and storage of water during high-runoff periods.

DoD natural resources policy states that wetlands will be protected to the extent possible. All activities that affect wetlands require an environmental analysis in accordance with AR 200-1, AR 200-2, and applicable federal and state laws and regulations. USACE permits are required under Section 10 of the Rivers and Harbors Act of 1899 prior to commencing any work or building any structures in a navigable water of the United States. Also, USACE permits are required under Section 404 of the Clean Water Act for the discharge of dredge or fill material into waters of the United States, including wetlands. The regulations established at Title 33 of the *Code of Federal Regulations* (CFR), Parts 320–330, prescribe the statutory authorities and general and special policies and procedures applicable to the review of applications for USACE permits. Before commencing any new work in waters of the United States, the USACE must be contacted and a permit obtained, as appropriate (HQDA, 1995b).

Executive Order 11990 requires that federal agencies minimize any significant action that contributes to the loss or degradation of wetlands and that action be initiated to enhance their natural value. Department of the Army policy is to avoid adverse impacts on existing aquatic resources and offset adverse impacts that are unavoidable. In addition, the Army will strive to achieve a goal of no net loss of the value and functions of existing wetlands and will permit no overall net loss of wetlands on Army-controlled lands. The Department of the Army will also take a progressive approach toward protecting existing wetlands, rehabilitating degraded wetlands, restoring former wetlands, and creating wetlands in an effort to increase the quality and quantity of the Nation's wetland resources (HQDA, 1995b).

3.7.1 Goals and Objectives

The main goal of wetlands management at Fort Hood is to continue to implement a program that is consistent with DoD natural resources policy and ensures no net loss of wetland habitat on Fort Hood. Activities occurring in or adjacent to wetlands that would result in negative impacts on the habitats will be avoided, when possible, in a manner consistent with mission objectives. Where impacts on wetlands are not avoidable, mitigation of the impacts will be implemented.

Goals and objectives for wetland management at Fort Hood are listed in Table 3-5 and discussed below.

Table 3-5
Goals and Objectives for Wetland Management

Goals	Objectives
Protect, maintain, and enhance wetlands, and ensure no net loss of these habitats.	Identify, delineate, and characterize the wetlands on Fort Hood.
	Evaluate potential impacts of current mission activities on wetlands and waters of the US, and determine need for permits.
	Establish a database to monitor habitat quality and ecological integrity.
	Develop a GIS data layer with available attributes.
	Pursue a formal agreement with USACE for its assistance to expedite permitting of future federal actions.
	Pursue water quality management procedures that protect wetlands from excessive nonpoint source runoff.
	Assess the need for a wetland management plan. Prepare and implement a wetland management plan if deemed necessary.

3.7.2 Monitoring

It will be necessary to monitor the integrity of wetlands following their identification, delineation, and characterization. The development of a database to monitor their status and trends not only will enable NRMB staff to determine future management efforts but also will facilitate the decision making process on future training and range actions.

3.7.3 Other Management Alternatives Considered

The development of the management measures described above provides the maximum amount of protection for wetlands without impeding the military mission. Other management alternatives considered, but rejected, were less comprehensive and therefore offered less protection. In addition, increasing the amount of information known about the wetlands at Fort Hood will provide the necessary data to properly monitor the systems. If the database was not increased, natural resources managers would not be able to track the success of the management practices or to adapt future management practices as needed. Failure to implement the proposed management measures could allow the degradation of Fort Hood's wetlands to go unnoticed.

A more intensive management alternative was also considered. This alternative restricted all activity in and around wetlands. This alternative was considered too restrictive and incompatible with the installation's military mission, and therefore it was dismissed.

3.8 FIRE MANAGEMENT/PRESCRIBED BURNING

Wildfire prevention and suppression is a matter of concern for military training and natural resources management at Fort Hood. Wildfires have several undesirable aspects: they interfere with ongoing training activities, they can make training areas unsuitable for training over the short term, and they have direct and indirect impacts on habitats and species. From an ecological standpoint, there are positive aspects to wildfire provided the fuel loads are not excessive, such as returning nutrients to the soil, releasing the seeds of fire-dependent plant species, increasing diversity, and causing an overall revitalization of habitat. For many years, Army guidance has focused strictly on the suppression of wildfires. Wildfire prevention and suppression involve minimizing fire occurrence by educating personnel and residents of Fort Hood on fire prevention techniques, reducing natural fire fuels, restricting the types of ammunition and pyrotechnics that can be used based on the level of fire danger, being well prepared for fires, and, when necessary, rapidly suppressing and containing the spread of wildfires that do occur.

3.8.1 Goals and Objectives

The goals and objectives (Table 3-6) reflect the change to a let-burn policy designed to reduce fuel loads and minimize interruptions of live-fire training exercises, while preserving endangered species habitat and protecting human health and facilities on and off the installation.

3.8.2 Monitoring

To minimize the potential impacts of fires on endangered species habitat, and in accordance with provisions listed in the 16 March 2005 Biological Opinion (BO) issued by USFWS for the revision of the Fort Hood Endangered Species Management Plan (ESMP), Fort Hood will monitor the effects of all fires on endangered species habitat.

3.8.3 Other Management Alternatives Considered

The fire management and prescribed burning measures proposed for Fort Hood are those minimally required for effective fire management and protection of endangered species habitat. Other management alternatives that require more or less aggressive fire management were considered but rejected. Because accidental fires result from the use of pyrotechnics and some types of ammunition during training, a more conservative alternative would involve increasing the restrictions on the use of pyrotechnics and ammunition or eliminating their use altogether. This management strategy would place an unacceptable level of restriction on training

Table 3-6
Goals and Objectives for Fire Management/Prescribed Burning

Goals	Objectives
Protect human life and suppress or prevent damage to land and natural resources caused by fire.	Continue the let-burn policy to minimize fuel loads. However, prevent unacceptable damage to natural resources and interference with training, and protect health and safety of personnel.
	Purchase fire suppression equipment and train personnel, on an as-needed basis.
	Continue to provide aerial fire fighting support.
	Suppress wildfires that threaten endangered species habitat and installation facilities.
Maintain firebreaks and construct new ones as needed to contain fires originating in the live-fire area and reduce the risk of fire damage to critical facilities, training activities, and endangered species habitat.	Maintain the road network in the live-fire area to provide some fire containment function.
	Maintain a 25-foot-wide bladed earth firebreak around the Fort Hood boundary, within constraints of erosion control BMP's.
	Minimize erosion on firebreaks.
	Maintain a firebreak around critical facilities such as fuel storage areas by controlling the vegetation by mechanical means and herbicides where necessary.
	Use soil sterilants for certain vegetation control needs. Mechanical control includes mowing, blading, or flaming.
	Construct and maintain firebreaks inside of and adjacent to endangered species habitat as required by the ESMP.
	Continue to provide aerial support for firebreak surveys.
Implement prescribed burning activities to control undesirable shrubs and trees, increase availability of forage and improve wildlife habitat, manipulate habitat for the endangered black-capped vireo, improve open space for military training, and reduce fuel loads to reduce the risk of wildfire.	Conduct prescribed burning to reduce fire hazards near black-capped vireo and golden-cheeked warbler habitat areas.
	Conduct prescribed burning year-round to minimize potential harm to endangered species habitat from training-related fires. The number of acres burned each season will depend on weather conditions and training schedules.
	Conduct cool season fires in black-capped vireo habitat to maintain patchy habitat structure and to limit the encroachment of juniper and other large trees.

Table 3-6
Goals and Objectives for Fire Management/Prescribed Burning (continued)

Goals	Objectives
	Investigate the use of prescribed fires in ecotone boundaries to protect golden-cheeked warbler habitat from catastrophic fires.
	Conduct prescribed fires to treat grasslands on a 5- to 7-year cycle, depending on conditions, burning approximately one fifth of appropriate grasslands on the installation per year. Burning the grasslands will limit woody encroachment on endangered species habitat.
	Train personnel with S-130 and S-190 basic fire suppression classes, as well as in intermediate and advanced fire-fighting techniques as necessary to maintain a wildland fire crew with the diverse skills and training needed to ensure safety and effectiveness.
	All personnel serving on the wildland fire crew must maintain fitness conditions appropriate to their assigned roles, up to and including Red Card certification, and be tested at least annually.

activities and the military mission, and therefore it was rejected. This conservative approach would also attempt to extinguish all wildfires outside the impact area regardless of whether they posed a direct threat to endangered species habitat, human health, or facilities. This approach could allow fuel loads to build to levels that would make it difficult to quickly and safely extinguish future fires. The fires of 1996 occurred during a time when fuel loads were very high and resulted in extremely hot fires that could not be contained and were difficult to extinguish. These extreme fires adversely affected training and destroyed a significant amount of endangered species habitat. The let-burn policy will assist in maintaining fuel loads at more manageable levels that should not result in extreme and difficult-to-control fires.

3.9 FISH AND WILDLIFE MANAGEMENT

3.9.1 Fisheries Management

Per AR 200-3, the fisheries management program on Army installations must provide for the management of fish populations and their habitats consistent with accepted scientific principles, in compliance with the ESA and other applicable laws and regulations. The program is to emphasize maintaining and restoring habitat favorable to the production of indigenous fish, particularly federally listed species protected under the ESA. In addition, fisheries stocks are to be managed to conserve both game and nongame species.

Habitat protection and the availability of suitable habitat are essential for productive fisheries and the successful management of the fisheries (USEPA, 1993). The condition of the surrounding watershed plays a significant role in determining the quality of the water and the physical habitat. The implementation of watershed management practices improves and protects the quality of the water resource and therefore must be incorporated into the fisheries management program.

Fort Hood's approach to fisheries management places a higher priority on habitat restoration aimed at creating ecosystems capable of producing self-sustainable populations of fish than on stocking. Long-term increases in fishing quality at relatively low costs are achieved more effectively by implementing habitat improvement and protection measures. Costs for enhancing or rehabilitating fish stocks are controlled by implementing self-sustaining habitat and water quality protection measures.

3.9.1.1 Goals and Objectives

The goal of fisheries management at Fort Hood is to provide quality recreational fishing opportunities while maintaining a balanced and diverse aquatic ecosystem. The best long-term approach, as well as the most efficient use of resources for achieving this goal, is to establish and maintain the biological integrity of the water bodies. The inability of water bodies to provide sustainable populations is often the result of habitat degradation, poor water quality, introduction of undesirable species, and overfishing. Table 3-7 lists the goals and objectives for fisheries management.

3.9.1.2 Monitoring

The monitoring methods used to manage the fisheries on Fort Hood will be consistent among water body types (i.e., lakes/ponds and streams) and from year to year. Such consistency allows the comparison of data between water bodies of a similar type, as well as the evaluation of temporal status and trends occurring for each water body. Management measures that produce the desired results will be continued for as long as they successfully meet their objectives.

Table 3-7

Goals and Objectives for Fisheries Management

Goals	Objectives
Provide quality recreational fishing opportunities while maintaining a balanced and diverse aquatic ecosystem.	Evaluate current fisheries, develop a database to evaluate the future condition of fish populations, and enhance fishing opportunities on Fort Hood.
	Assess the need for electrofishing, sampling, and monitoring of fish populations, and implement as needed.
	Continue to develop and expand recreational fishing opportunities.
Protect, restore, and enhance aquatic ecosystems to protect water quality and support an adequate fisheries resource.	Assess aquatic habitat and develop a database from which to determine status and trends of physical habitat conditions and overall ecological integrity. Use the database as baseline information to assess future conditions. Protect the biological integrity of streams.
	Control/eradicate exotic and undesirable species in lakes and ponds.
Maintain, protect, and enhance riparian areas to protect water quality, aquatic habitat, and fisheries and to enhance native biodiversity.	Maintain riparian buffer zones along streams, lakes, and ponds.
Enhance fish habitat.	Where necessary, conduct silt removal, bottom contouring, shoreline diversification, dam and spillway renovation, and riparian habitat management.
	Monitor aquatic weeds and implement necessary control measures.
Manage fish harvests to maintain fish populations within the capacity of available habitat.	Continue to obtain adequate data to support the development of sustainable fish harvests.
Continue the reduction of sheet, rill, and gully erosion to acceptable limits.	Evaluate and prioritize a list of active erosion sites.
Assess existing best management practices.	Continue to improve the program through research and implementation of new management practices.

3.9.1.3 Other Management Alternatives Considered

Restricting access to the riparian and aquatic areas at Fort Hood was considered, but it was rejected because training restrictions in those areas would impede training under realistic conditions. Improving water crossings for all the streams at Fort Hood to protect the integrity of the aquatic habitats was also considered. However, the more prudent allocation of resources involves prioritizing stabilization projects on the basis of need. In addition, ground-disturbing activities associated with such projects could contribute additional sediment loads and disturb aquatic habitats during the stabilization process. It is possible to protect, conserve, and enhance the aquatic habitats at Fort Hood to ensure long-term ecological integrity, support healthy fish populations, and provide recreational opportunities without placing undue restrictions on the military mission. Therefore, implementation of these other management alternatives is not necessary.

A more intensive (and traditional) approach to fisheries management, in which management techniques focus on more intensive manipulation of the food chain, gamefish stocks, and increased levels of stocking, was considered. This intensive or traditional approach to fisheries management is more costly and less effective in the long term than the approach presented above. Habitat improvement and protection measures are far more effective than intensive stock manipulation and stocking, and they have a higher probability of producing long-term improvements in the quality of recreational fishing at relatively low costs.

3.9.2 Wildlife Management

3.9.2.1 Goals and Objectives

The goals of the wildlife management program (Table 3-8) are to sustain indigenous wildlife species through the use of integrated ecosystem management principles while accommodating military training needs. Furthermore, wildlife resources and habitats for consumptive and nonconsumptive uses are to be managed in compliance with federal and state laws (Sikes Act, ESA, Clean Water Act [CWA], state laws), and U.S. Army regulations (e.g., AR 200-3) and guidance.

3.9.2.2 Monitoring

The management objectives described above are designed to characterize existing conditions, determine management measures, and provide a database from which to evaluate and monitor the status and trends of wildlife resources at Fort Hood. The monitoring methods used to evaluate wildlife resources on Fort Hood will be consistent among habitat types and from year to year. This consistency allows the comparison of data between areas of a similar habitat type, as well as the evaluation of temporal status and trends. Management measures that produce the desired results will be continued for as long as they successfully meet their objectives. The inventory and monitoring data will be evaluated at regular intervals to ensure the continued successful management of wildlife resources at the ecosystem level. Management measures that do not produce the desired objective will be reevaluated to determine the corrective action needed to ensure success.

Table 3-8

Goals and Objectives of Wildlife Management

Goals	Objectives
Sustain wildlife resources and habitats for consumptive and nonconsumptive uses that are managed in compliance with federal and state laws (Sikes Act, ESA, CWA, state laws) and U.S. Army regulations (e.g., AR 200-1) and guidance.	Improve habitat quality for wildlife species and ensure healthy wildlife populations in a manner consistent with land use and training objectives.
	Manage native vegetation to promote optimal community succession.
	Conduct prescribed burning to reduce fuel loads and improve wildlife habitat.
	Maintain existing drinking water availability.
	Manage grazing and continue deferment program.
	Enhance the value of ecosystems by eradicating exotic animal and plant species, promoting native plant communities, preventing the introduction of new weeds, and restoring areas disturbed by training.
Develop a standardized, coordinated system for recording and mapping resource observations (e.g., plants, wildlife, erosion, damage).	Ensure that scientifically sound and commonly accepted data collection methods and sampling techniques are used to update natural resource inventories.
	Continue to monitor medium-large carnivore distribution and composition.
	Evaluate and research factors influencing deer populations.
	Continue RTLA monitoring as a component of ecosystem management.
Manage wildlife harvests to maintain game populations within the capacity of available habitat.	Continue to obtain adequate data to support the development of sustainable wildlife harvests.
	Continue to provide aerial support for wildlife surveys.
Continue environmental awareness and outreach programs.	Continue support and development of the Fort Hood Outdoor Recreation Program.

3.9.2.3 Other Management Alternatives Considered

A lower-intensity approach to wildlife management, in which management techniques would be minimized and implemented on a smaller scale, was considered. Under a lower-intensity management approach, fewer steps would be taken to manage terrestrial habitat resources and management would more closely resemble the status quo, or less. For example, Ashe juniper would not be cleared using mechanical means. Although the effect of such a course of action would be gradual and not immediately apparent, the long-term impacts could be very detrimental to the military mission and to biodiversity. For example, further reduction in open areas over the next decade and increased stands of dense Ashe juniper would likely result in areas where training was no longer possible.

Ultimately, the ability of the installation to support the mission would be impaired due to a reduction in open training areas, particularly those suitable for maneuvers. Furthermore, it is conceivable that with a lower-intensity management scheme additional species might become federally listed, resulting in additional training restrictions. Thus, lower-intensity management of terrestrial habitats was eliminated from further consideration.

3.10 RARE, THREATENED, AND ENDANGERED SPECIES MANAGEMENT

3.10.1 Federally Listed Species

The ESA requires all federal agencies to conserve listed species. Conservation, as defined by the ESA, means the use of all methods and procedures necessary to bring any listed species to the point where protections pursuant to the ESA are no longer necessary. The act specifically requires agencies not to "take" or "jeopardize" the continued existence of any endangered or threatened species, or to destroy or adversely modify habitat critical to any endangered or threatened species. Under Section 9 of the act, *take* means to "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect"; under Section 7, *jeopardize* means to engage in any action that would be expected to "reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species."

On 28 September 1994 the Acting Assistant Secretary of the Army (Civil Works) signed a multi-agency Memorandum of Understanding (MOU) on implementing the ESA. The purpose of the MOU was to establish a general framework for greater cooperation and participation among the agencies exercising their responsibilities under the ESA. The MOU states that the departments will work together to achieve the common goals of (1) conserving listed species, (2) using existing federal authorities and programs to further the purposes of the ESA, and (3) improving the efficiency and effectiveness of interagency consultations conducted pursuant to Section 7(a) of the ESA. Each signatory agreed to (1) use its authorities to further the purposes of the ESA by carrying out programs for the conservation of federally listed species, including implementing appropriate recovery actions that are identified in recovery plans; (2) identify opportunities to conserve federally listed species and the ecosystems on which they depend within existing programs and authorities; (3) determine whether its respective planning processes effectively help conserve threatened or endangered species; and (4) use existing programs, or establish a program, to evaluate and reward the performance of personnel who are responsible for planning or implementing programs to conserve or recover listed species or the ecosystems on which they depend.

Army policy on listed species includes the following elements: balancing mission requirements with endangered species protection, cooperating with regulatory agencies, and conserving biological diversity within the context of the military mission. As required by AR 200-3, the Army must ensure that it carries out mission requirements in harmony with the requirements of the ESA. All Army land uses, including military training and testing, recreation, and grazing, are subject to ESA requirements for the protection of listed species and critical habitat. In fulfilling its conservation responsibilities, the Army is required to work closely and cooperatively with the USFWS and National Marine Fisheries Service (NMFS), the two federal agencies responsible for enforcing the act. Installations are encouraged to engage in informal consultation with the USFWS and NMFS during the planning of projects or activities to ensure ESA compliance. In conserving biological diversity, installation commanders and Army natural resource managers are required to develop and implement policies and strategies to maintain viable populations of native plants and animals, maintain natural genetic variability within and among populations, maintain functioning representations of the full spectrum of ecosystems and biological communities, and integrate human activities with the conservation of biological diversity.

AR 200-3 requires installations to prepare ESMPs for each listed species and species proposed for listing and the critical habitat present on the installation, including areas used by tenant organizations. Installations that require more than one ESMP (i.e., more than one listed or proposed species is present) are permitted to prepare a combined ESMP provided the combined plans satisfy the substantive requirements detailed in AR 200-3, Chapter 11-5(b) (3 and 4). Installation ESMPs must prescribe area-specific measures necessary to meet the installation's conservation goals for the subject species and critical habitats (HQDA, 1995b).

3.10.1.1 Goals and Objectives

The management goals for rare, threatened, and endangered species on Fort Hood are to preserve these species on the installation in accordance with the Endangered Species Act, Endangered Species Recovery Plans, U.S. Army regulations and guidance, approved ESMPs, and BOs. Table 3-9 lists the goals and objectives for the management of rare, threatened, and endangered species.

Table 3-9

Goals and Objectives for Rare, Threatened, and Endangered Species Management

Goals	Objectives
Manage all identified rare, threatened, and endangered species in accordance with the ESA, U.S. Army regulations and guidance, state wildlife regulations/laws, and approved site-specific management plans (e.g., ESMP).	Continued ongoing monitoring of intensive study areas to assess critical demographic parameters of golden-cheeked warblers and black-capped vireos.
	Implement new or restructure existing monitoring programs to assess long-term effects on bird populations as a result of changes in core habitat designations.
	Actively manage black-capped vireo habitat in accordance with the provisions of the ESMP.
	Mark T&E habitat with signage.
	Remove signage from habitat that has been revised from core to non-core habitat.
Protect and enhance the habitat and populations of those plant and animal species listed as rare, threatened, and endangered or those with the potential to be listed in the future.	Assess the need for additional monitoring or research for those species with the potential to become listed in the future, particularly those species identified by Partners in Flight as regional species of concern.
	Continue support for the MAPS station and evaluate additional survey needs.
	Continue to monitor for the presence of Species of Conservation Concern and collaborate with researchers who are studying declining species.
	Continue to provide aerial support to monitor land use impacts in endangered species habitat.
Continue cowbird control through an active trapping and shooting program throughout the post and enhance control in core habitat areas.	Maintain parasitism levels in black-capped vireo nests below 10%.
Continue support and encouragement of research programs that assess the effects of military training activities on endangered bird populations.	Continued monitoring to determine population trends, demographic parameters, and effectiveness of management initiatives.
Continue support for range-wide population and habitat conservation and protection measures.	Assess the feasibility and desirability of participating in regional surveys of selected species and habitat types to contribute to the understanding of Fort Hood's regional contribution to species and habitat conservation and recovery.
	Continue to collaborate and cooperate with agencies and organizations conducting monitoring and conservation of listed species on the wintering grounds, including collaborative training and data-sharing.
Ensure that scientifically sound and commonly accepted data collection methods and sampling techniques are used.	Continue to develop and assess new and innovative survey techniques for endangered species.

3.10.1.2 Monitoring

The ESMP and 16 March 2005 BO include provisions for monitoring. The reasonable and prudent measures outlined in the BO (Appendix J) includes (1) continuing to implement monitoring and research programs for the golden-cheeked warbler and black-capped vireo; (2) managing vegetation-clearing projects to minimize fire hazard from slash and to avoid impacts on residual stands; (3) emphasizing the use of prescribed burning to support protection and maintenance of endangered species habitat and to support ecosystem management principles; (4) evaluating the effects of predation on endangered species productivity and investigating management options to reduce nest losses; (5) monitoring the quality and quantity of available endangered species habitat; (6) incorporating preventive measures to avoid future uncontrolled burns similar to the February 1996 fires; (7) implementing training restrictions in golden-cheeked warbler core habitat; (8) monitoring the distribution and spread of oak wilt and using appropriate measures to limit effects on endangered species habitat; and (9) restricting recreational use in endangered species habitat.

In addition, the BO recommends the following conservation practices:

- Continue monitoring and managing the habitat of the endemic cave invertebrates and salamander species. This would include developing and implementing a management plan and providing adequate protection for these ecosystems.
- Consider black-capped vireo and golden-cheeked warbler habitat when implementing ACUB activities. This would include extending management and monitoring activities to lands used for buffer purposes when possible.
- Continue work on an off-site conservation plan that would support the on-the-ground work of non-governmental organizations dedicated to the conservation of the black-capped vireo and golden-cheeked warbler.

3.10.1.3 Other Management Alternatives Considered

Because protection of federally listed species is mandated by federal law and protection of state-listed and rare species is required by Army regulation, other management alternatives that would have afforded less protection to these species were not considered. A lower-intensity management approach to threatened and endangered species would include reducing or easing management for these species altogether. That management approach was rejected because it would not comply with the spirit of AR 200-3 or comply with the agreed-upon provisions of the Fort Hood ESMP and the 2005 BO.

3.10.2 Karst Management

Fort Hood covers three karst fauna regions. The regions, as described earlier in this report, are defined on the basis of geologic and hydrologic continuity and the distribution of troglobitically advanced species. Subregions are zones within karst fauna regions that have different faunal assemblages.

Karst fauna regions and subregions can be further divided into "karst fauna areas." USFWS (1994) described the karst fauna area as "known to support one or more locations of the listed species [species of concern at Fort Hood] and is distinct in that it acts as a system that is separated from other karst fauna areas by geologic and hydrologic features and/or processes that create barriers to the movement of water, contaminants, and troglobitic fauna." The purpose of the karst fauna areas in managing the species of concern is to establish areas such that if a catastrophic event (e.g., contamination, quarrying, flooding) that might kill species or destroy habitat occurs in one area, it will not affect species or habitat in other areas.

There are several threats to the species of concern on Fort Hood. Most threats to cavernicole species are related to urban growth into the karst regions and the subsequent loss of habitat, as well as direct impact on the species. Generally, these threats or their potential is present to a lesser degree at Fort Hood than in urbanizing areas.

Fort Hood has prepared a Karst Management Plan designed to eliminate, mitigate, and prevent harm to the species of concern. By proposing a plan for all species of concern, not just those proposed for endangered listing, Fort Hood can take a broader and more effective ecosystem-based approach to species management, similar to habitat conservation plans.

3.10.2.1 Goals and Objectives

The goals and objectives established by Fort Hood to protect the karst habitats and the associated species of concern are provided in Table 3-10.

Table 3-10

Goals and Objectives for Karst Management

Goals	Objectives
Conserve rare and endemic invertebrates and salamanders and their habitat throughout the karst landscape of Fort Hood. Karst landscape identifies the caves, sinks, and the network of dendritic fissures and cracks that supply nutrients to and from the cave.	Continue to identify karst features with significant faunal assemblages
	Continue to determine the appropriate size and shape of karst fauna areas targeted for management.
Provide protection to targeted karst fauna areas. Specific protective measures include installing rock (physical) barriers, protecting the areas from vegetation clearing, implementing erosion control practices, manipulating vegetation to decrease juniper around certain caves, and protecting cave watersheds.	Evaluate and prioritize a list of caves that require cave gates.
	Identify training effects on karst areas and disseminate educational information to soldiers and trainers to raise awareness.
	Limit use of chemicals at and near karst preserve locations.
	Control new juniper growth and manage existing juniper as appropriate in karst fauna areas.
	Implement conservation measures and management of targeted karst fauna areas.
	Continue ongoing research and conduct additional research about the life history of rare and endemic invertebrates and salamanders, as well as karst hydrology and geology.
	Continue to survey, map, and sample the biota in known and newly discovered karst features in conjunction with the Karst Management Plan.
	Protect the karst surface and subsurface watershed. The subsurface watershed is the dendritic network of cracks and fissure around a feature that direct nutrients and water underground.
	Protect surface area and vegetation as appropriate to conserve cave cricket populations
Continue bat conservation activities.	Continue to monitor and protect the maternal colony of cave myotis (*Myotis velifer*) on the western maneuver area.
	Continue to monitor and manage bat caves in the live-fire area.
	Continue consultation and collaboration with governmental and non-governmental cave and cave biota management organizations.
Control or eradicate fire ants near karst systems.	Evaluate and prioritize a list of karst systems that require non-pesticidal (e.g., hot water or steam) fire ant control.
	Research and develop a monitoring plan for assessing the impact of fire ants on karst systems.

Table 3-10
Goals and Objectives for Karst Management

Goals	Objectives
	Continue to coordinate with researchers investigating the use of Strepsiptera as a viable biological fire ant control.

3.10.2.2 Monitoring

All karst fauna areas targeted for conservation should be monitored to determine the success or failure of the management actions implemented and to guard against irreversible declines in the species' status. The status of the species of concern, their karst fauna areas both above and below ground, and existing or potential threats to either should be monitored on a basis recommended by the USFWS. Monitoring criteria that are as quantitative as possible should be developed to minimize sampling or interpretational bias and to facilitate comparison between monitoring periods and other observations. The results of the monitoring should be assessed periodically to determine whether changes, additions, or deletions to the conservation program are needed.

Any monitoring program should take care not to adversely affect cave fauna. It is both impractical and probably harmful to do intensive, regular detailed monitoring of many of the small caves. Larger caves, where only selected areas are monitored, can be safely monitored two to four times a year. In the event that major land use modifications are planned in the vicinity of a karst fauna area, one or more detailed biological surveys of the cave should be conducted, with follow-up monitoring after modification. Any cave in a potentially affected karst fauna area should be studied immediately after the event. Additional surveys should be conducted if there is evidence of an adverse impact on the karst ecosystem or, especially in the event of a spill of hazardous materials, several surveys should be conducted to determine whether pollution is occurring later. Caves should also be monitored if heavily affected by flooding or fires.

The Karst Management Plan provides detailed descriptions of the actions necessary to monitor the karst features of Fort Hood (Appendix K). The monitoring efforts identified in the Karst Management Plan include the following:

1. Identifying karst fauna areas that meet the Karst Management Plan criteria
2. Determining the appropriate size and shape of the karst fauna areas targeted for management
3. Providing long-term protection to targeted karst fauna areas
4. Implementing conservation measures and managing targeted karst fauna areas
5. Conducting additional research

6. Developing educational materials and programs
7. Continuing monitoring

In addition to these monitoring efforts, the Karst Management Plan identifies monitoring efforts for karst features that contain species of concern (Appendix K). The complete details of these monitoring efforts are provided in the Karst Management Plan. The monitoring efforts for karst features with species of concern may include the following:

1. Preserving the general ecology and water quality and quantity
2. Protecting surface area for cave crickets
3. Controlling or eradicating fire ants
4. Installing cave gates to protect species of concern
5. Limiting the use of chemicals at nearby locations
6. Controlling new growth of juniper in karst fauna areas
7. Identifying species of concern present

3.10.2.3 Other Management Alternatives Considered

Species that are candidates for federal listing or are state-listed as threatened, endangered, or of special concern are not protected under the ESA. However, because candidate species might be listed in the future, installations are required to avoid taking actions that result in the need to list candidates as threatened or endangered and are encouraged to participate in conservation agreements with the USFWS. For state-listed species, installations are encouraged to cooperate with state authorities in efforts to conserve these species.

Because Army regulations require protection of state-listed and rare species, other management alternatives that would have afforded less protection to these species were not considered. A lower-intensity management approach to karst management would include reducing or ceasing management for these species and their habitat altogether. That management approach was rejected because it would not comply with the spirit of AR 200-3.

3.11 FOREST/WOODLAND MANAGEMENT

Ecosystem management provides a framework for holistic management of the resource rather than focusing emphasis on a single aspect or activity, such as timber production or game species management. The forest/woodland management program at Fort Hood is aimed at maintaining and enhancing the ecological integrity of the habitat and ensuring that training is not impeded by the encroachment of junipers. Currently, Fort Hood has no timber harvest program, and none is anticipated for the future. Using an ecosystem management approach, NRMB can provide for the following:

- Biodiversity of species and habitat
- Natural beauty
- Outdoor recreation opportunities
- Wildlife habitat, particularly endangered species habitat
- Soil conservation, erosion control, and watershed protection
- Air and water quality
- Sustained viability and diversity of military training lands

3.11.1 Goals and Objectives

The goal and objective for forest/woodland management at Fort Hood are provided in Table 3-11.

Table 3-11

Goals and Objectives for Forest/Woodland Management

Goal	Objective
Protect and enhance forest/woodland composition and structure to support endangered species and other wildlife.	Evaluate potential negative impacts of oak wilt on woodlands. Implement control measures where and when necessary.

3.11.2 Monitoring

Forest and woodland management efforts are directed at protecting wildlife and endangered species habitat from *Ceratocystis fagacearum,* the fungus that causes oak wilt. The provisions prescribed by the 16 March 2005 BO (Appendix J) include monitoring the distribution and spread of oak wilt centers and using appropriate measures to limit effects on endangered species. Future control measures implemented to control oak wilt will be monitored to evaluate their efficacy in minimizing the impacts on surrounding trees, as well as the cost-effectiveness of implementing these measures installation-wide.

3.11.3 Other Management Alternatives Considered

More intensive management efforts were considered but rejected. Intensive forest management efforts are not necessary to promote conditions to maintain ecosystem integrity or to support or enhance training. More efforts to manage the forests and woodlands at Fort Hood would direct limited funds and resources away from programs requiring more intensive management.

3.12 AGRICULTURAL OUTLEASING (GRAZING)

The original landowners of what is now Fort Hood have been allowed to graze cattle through the outlease program. The Central Texas Cattlemen's Association (CTCA) administers the leasing of the land by the cattlemen, and the leases run for a period of 5 years. Prior to the renewal of a lease, Fort Hood evaluates the conditions of the training lands to determine the level of grazing that can occur without degrading the training lands, impeding the military mission, and endangering the long-term sustainability of Fort Hood's resources.

On 8 April 2005 the Department of the Army executed a new lease agreement with the CTCA for the purposes of grazing cattle on the training lands at Fort Hood. As part of the lease agreement, the cattlemen must abide by the provisions in the Land Use Regulations (LUR), included as Exhibit B in the Lease Agreement. The purpose of the

LUR is to ensure that all grazing activities are conducted in a manner consistent with national policy intended to do the following:

- Provide for multiple uses of the premises (Fort Hood) for military purposes, wildlife habitat, public recreation, water conservation, and domestic livestock grazing
- Preserve, sustain, and enhance the natural resources of the premises (Fort Hood)

3.12.1 Goals and Objectives

The primary goal of the grazing program at Fort Hood is to permit cattle grazing while ensuring the long-term sustainability of the training lands and unimpeded military training. The goals and objectives of the program are provided in Table 3-12.

Table 3-12

Goals and Objectives for Agricultural Outleasing (Grazing)

Goals	Objectives
Allow cattle grazing to the extent that impacts on training, training lands, and natural resources can be maintained at acceptable levels.	Implement the stocking rate formulas defined in the Supplemental Grazing Environmental Assessment and the approved grazing management plan.
Develop a long-term plan for grazing management.	Develop and implement a Grazing Management Plan. A copy of the GMP will be included as an appendix (Appendix L) to the INRMP upon completion.
Evaluate new methodologies for calculating cattle stocking rates	A predictive forage response model is currently in development by Texas A&M University's Ranching Systems Group that shows promise to assess and predict forage response and fire risk to emerging conditions. Use of this model, if validated and approved by the Department of the Army, is proposed by Texas A&M to be integrated with a multiple model system for assessing and predicting Fire behavior, erosion and forage to assist Fort Hood with land management decisions where cattle grazing coincides with the military training mission. While the model(s) shows merit, a key component of its validated accuracy will be the system's capability to assess and predict forage loss throughout the year due to Fort Hood's military training mission and fluctuating military traffic intensity.
Monitor lessee performance	Develop a lease surveillance plan to monitor the lessee's performance of work requirements.
	Design and implement enforceable provisions to ensure that the lessees comply with the stocking rates authorized by the lease.

3.12.2 Monitoring

Fort Hood is finalizing a Grazing Management Plan (GMP; to be included as Appendix L) that will integrate the management of cattle grazing with Fort Hood's mission and environmental stewardship responsibilities. Monitoring measures are being built into the GMP to ensure that grazing at current levels is not jeopardizing the long-term sustainability of the training lands, resulting in irreparable harm to the natural resources, including increased erosion rates, sedimentation in the water bodies, and changes in the character of the rangeland vegetation.

Previous monitoring efforts to evaluate compliance with lease provisions have had limited success. Containment of cattle to designated grazing/training areas is naturally difficult without fencing. A more robust monitoring program must be implemented to ensure compliance and to avoid degradation of the training lands. A lease surveillance plan detailing compliance and monitoring measures could be developed for incorporation into future lease agreements and land use regulations. The lease surveillance plan would identify the lease provisions to be monitored and the manner in which compliance or noncompliance will be determined, documented, and reported.

Measures that could be incorporated into the lease surveillance plan could include the following:

- Identification, counting, and reporting of cattle that interfere with or interrupt training exercises. Penalties for repeat offenders should be implemented and enforced.

- Random aerial surveys to monitor cattle locations and numbers. Surveys would be conducted concurrent with other aerial support operations.

The implementation of compliance monitoring could ensure the protection of Fort Hood's natural resources, minimize environmental damage and degradation, and protect endangered species habitat. Monitoring and compliance provisions could be incorporated into future grazing leases and land use regulations. Penalties for noncompliance could be established and incorporated into the LUR.

3.12.3 Other Management Alternatives Considered

Less intensive management alternatives were considered but rejected. Overuse by cattle in the past has resulted in degraded rangeland vegetative cover, severely eroded training lands, and numerous interruptions of training exercises. Applying a more liberal use of training lands for grazing could adversely affect the long-term sustainability of training lands and increase interruptions of training. This would be increasingly likely as more troops are transferred to Fort Hood as a result of Army Transformation and Modularity. Measures to protect the golden-cheeked warbler and black-capped vireo must be implemented to ensure compliance with the ESA and BO.

More intensive management alternatives were also considered but rejected. Fort Hood has had a long-standing relationship with the local cattlemen and is committed to providing multiple uses of its resources. More conservation management alternatives are not necessary provided that overuse does not adversely affect the long-term sustainability of the training lands and that sediment loads to the water resources serving the surrounding communities do not degrade water quality, aquatic habitat, and water supply capacity.

3.13 Invasive Species Management

Executive Order 13112, *Invasive Species*, was signed in February 1999 to prevent the introduction of invasive species; provide for their control; and minimize the economic, ecological, and human health impacts from such species. Invasive species are defined by EO 13112 as alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health. Per EO 13112, each federal agency whose actions might affect the status of invasive species must, to the extent practicable and permitted by law, use relevant programs and authorities to

1. Prevent the introduction of invasive species
2. Detect and respond rapidly to and control populations of such species in a cost-effective and environmentally sound manner
3. Monitor invasive species populations accurately and reliably
4. Provide for restoration of native species and habitat conditions in ecosystems that have been invaded
5. Conduct research on invasive species and develop technologies to prevent their introduction and to provide for their environmentally sound control
6. Promote public education on invasive species and the means to address them

The control of invasive species is a priority for the pest management staff, as well as the fish and wildlife biologists in the NRMB. Management actions for the pest management program, which includes invasive species, are provided in the 2002 Pest Management Plan.

3.13.1 Goals and Objectives

The goals and objectives for the prevention of new infestations and the control of existing infestations of invasive species are provided in Table 3-13.

Table 3-13

Goals and Objectives for Invasive Species Management

Goals	Objectives
Prevent new infestations of invasive species.	Report new infestations of invasive weed species to natural resources personnel.
Prevent the introduction of invasive species.	Prohibit the planting of invasive species in ornamental landscaping, in wildlife supplemental food plots, and in revegetation projects per MOI, *Landscaping on Fort Hood* (10 May 2004).
Control invasive plant, insect, and mammal species to prevent degradation of training areas with respect to safety, training, and wildlife management.	Control invasive species on improved grounds using mechanical and biological control methods and approved chemical control methods when necessary.
	Control unwanted aquatic plants in managed fisheries ponds with mechanical (shoreline shaping), physical (water level fluctuations), and biological and chemical methods.
	To the extent deemed necessary by NRMB staff to protect other resources, control Ashe juniper by prescribed burning and mechanical methods.
	Control invasive fire ants in the cantonment area and in non-karst landscapes using approved pesticides and other methods.
	Use all practical means to control and prevent spread of feral hogs on the installation.
	Conduct research to evaluate new ways to control feral hog species.
	Continue to provide aerial support for feral hog control.
	Continue to document and map occurrences of key exotic/invasive species that are observed during survey efforts or incidentally encountered; use this information to schedule and prioritize management actions for such species.
Conduct restoration activities after invasive species control to repair areas vulnerable to erosion, and also to prevent other invasive plants from invading disturbed soil.	Reseed native grasses in bare soil resulting from mechanical control of invasive plants.

3.13.2 Monitoring

Monitoring for invasive species is integrated into the monitoring programs for other resources, such as terrestrial, aquatic, karst, and endangered species habitat; fish; and wildlife, as well as pest management.

3.13.3 Other Management Alternatives Considered

Two other management alternatives for pest management were considered: (1) lower- intensity management and (2) higher-intensity management. The invasive species management measures in use at Fort Hood are relatively low in intensity. Lowering that intensity further would not provide sufficient control of invasive species and nuisance animals, which would create a potential for those species to adversely affect Fort Hood and increase ecological risks. More intensive invasive species management measures would result in increased usage of pesticides and herbicides, as well as hunting and trapping of feral animals. More aggressive efforts to eliminate exotic and invasive species might further reduce their populations in targeted areas, but the relatively low incremental benefit would not offset the significant implementation costs. Therefore, higher-intensity management approaches were also dropped from further consideration.

3.14 PEST MANAGEMENT

Per AR 200-5, *Environmental Quality: Pest Management* (HQDA, 1999), Fort Hood's Integrated Pest Management Plan (IPMP) defines and describes essential elements of the pest management program, such as health and environmental safety; pest identification; and pesticide storage, transportation, use, and disposal. The plan is used as a tool to reduce reliance on pesticides, to enhance environmental protection, and to maximize the use of Integrated Pest Management techniques. In addition, the plan provides guidance for the judicious use of both chemical and nonchemical control techniques to achieve effective pest management with minimal environmental contamination. Adherence to the plan ensures effective, economical, and environmentally acceptable pest management and compliance with pertinent laws and regulations.

3.14.1 Goals and Objectives

The goal of the pest management program is to protect human health and suppress or prevent damage to real estate and natural resources caused by pests. The objective of the pest management program is to use integrated pest management techniques to eliminate, suppress, or control pests using the judicious use of both chemical and nonchemical control techniques. Table 3-14 provides a list of the goals and objectives.

Table 3-14

Goals and Objectives for Pest Management

Goals	Objectives
Protect human health and suppress or prevent damage to real estate and natural resources caused by pests.	Use integrated pest management techniques to eliminate, suppress, or control pests with the judicious use of both chemical and nonchemical control techniques.
Provide oversight of installation pest management IAW AR-200-5.	Assure compliance with federal and state laws and the IPMP.
Implement Integrated Pest Management practices.	Continue to provide pest monitoring.
	Provide outreach education in nonchemical and reduced-chemical control methods.
	Encourage the creation of favorable yard habitats in Fort Hood family housing for beneficial insects and other wildlife.
Reduce the quantity of toxic pesticide used on the installation and promote more effective pest control practices.	Evaluate the effectiveness of control programs.
	Implement new pesticide reduction methodologies and equipment initiatives.
Implement bat conservation and control in installation buildings.	Implement IPMP and DPW SOP on bat exclusion procedures.
	Implement educational outreach on the beneficial aspects of bats and safety around bats.
Implement bat conservation.	Investigate the practicality of providing alternative housing for bats excluded from buildings. Work with Bat Conservation International and TPWD for strategies and professional guidance.
	Consider developing and implementing installation SOPs for wildlife protection measures during construction and demolition activities in an effort to minimize adverse effects on bats and other wildlife during these activities.
Remove or reduce exotic/invasive wildlife species on the installation.	Continue removal of individual exotic/invasive wildlife species, especially feral hogs, and develop plans for their eradication.
	Continue to provide aerial support for the control of exotic / invasive wildlife.
	Document occurrences of key exotic/ invasive wildlife (e.g., species with potential to affect listed species) that are observed during survey efforts or incidentally encountered; use this information to schedule and prioritize exotic management actions.
	Assess the need for installation-wide surveys and mapping of invasive/exotic species.

3.14.2 Monitoring

The monitoring program for the pest management program is detailed in the Fort Hood IPMP.

3.14.3 Other Management Alternatives Considered

Two other management alternatives for pest management were considered: (1) lower- intensity management and (2) higher-intensity management. The pest management measures in use at Fort Hood, as described in the IPMP, are relatively low in intensity. Lowering that intensity further would not provide sufficient control of invasive species and nuisance animals, which would create a potential for those species to adversely affect Fort Hood and increase human health risks. More intensive pest management measures would result in increased usage of pesticides. This would be counterproductive and counterdirective to the Army's goal of reducing pesticide usage. More aggressive efforts to eliminate pests such exotic and invasive species might further reduce their populations in targeted areas, but the small incremental benefit would not offset the significant implementation costs. Therefore, higher-intensity management approaches were also dropped from further consideration.

3.15 OUTDOOR RECREATION

The Fort Hood Directorate of Morale, Welfare and Recreation (MWR) supports the largest active duty armored post in the United States, enhancing the quality of life by providing numerous recreation opportunities and services. As described in Section 2.1.12, Fort Hood offers a wide variety of outdoor recreational opportunities from horseback riding, swimming, camping, and mountain biking at BLORA to hunting, fishing, and trapping out in the training lands.

The Sportsmen's Center encourages interest in hunting, fishing, and other outdoor recreation activities and is devoted to the conservation and presentation of wildlife, their habitats, and the environment; the sports of hunting, fishing, and archery; and the recreational use of guns for skeet, trap, or other target shooting.

Fort Hood's NRMB provides support to the outdoor recreational program by protecting and enhancing the natural resources on which these recreational activities rely.

3.15.1 Goals and Objectives

NRMB's primary goal for supporting recreational opportunities is to ensure that the natural resources maintain their ecological integrity and that the recreational pursuits do not adversely affect endangered species (Table 3-15).

Table 3-15
Goals and Objectives for Outdoor Recreation

Goals	Objectives
Provide quality consumptive and nonconsumptive recreational opportunities while avoiding impacts on training and maintaining a balanced and diverse ecosystem.	Continue to monitor and enforce BLORA bike park and horse riding trail operational procedures and maintenance schedules.

3.15.2 Monitoring

Most of the monitoring done to support recreational opportunities like hunting, fishing, and trapping is discussed under Sections 3.9.1, *Fisheries Management*, and 3.9.2, *Wildlife Management*. Fort Hood conducted a 5-year study to evaluate the potential impacts of recreational mountain biking in BLORA on golden-cheeked warbler populations in the area (Pekins, 2002). The study concluded that mountain biking at current intensity levels did not have an apparent adverse impact on the species. Fort Hood will continue to monitor recreational activities in BLORA to ensure that these populations continue to remain unaffected.

3.15.3 Other Management Alternatives Considered

A higher-intensity management alternative that included more intensive measures to enhance recreational opportunities was considered but rejected. Most of these activities have been discussed in Sections 3.9.1.2 and 3.9.2.2, and they include more intensive measures to enhance fisheries and wildlife populations. As previously discussed, the most resource-efficient management approach is (1) to focus on maintaining and improving the ecological integrity of terrestrial and aquatic habitat and (2) to ensure that incremental increases in the intensity of management activities to enhance populations will not result in proportional incremental increases in recreational opportunities. Therefore, a higher-intensity management alternative would not be a prudent use of resources.

3.16 LAW ENFORCEMENT PROGRAM

Effective enforcement of laws and regulations applicable to natural resources enhances the overall natural resources program, protects the natural and cultural resources, and provides public safety by enforcing off-limit areas and providing protection from criminal destruction of natural resources (i.e., activities such as trespassing and poaching).

3.16.1 Goals and Objectives

The primary goal of law enforcement at Fort Hood is the enforcement of natural resources laws and regulations. The objectives that will be implemented to ensure that goal is achieved are presented in Table 3-16.

Table 3-16
Goals and Objectives for Law Enforcement

Goals	Objectives
Protect the natural resources of Fort Hood by enforcing laws and regulations.	Ensure that all laws and regulations pertaining to natural resources at Fort Hood are in accord with the laws and regulations of the United States and the state of Texas.
	Adopt additional laws and regulations that adequately protect the natural resources of Fort Hood.
	Maintain staffing levels of trained and capable natural resource law enforcement personnel sufficient to effectively monitor and enforce all natural resource laws and regulations. Ensure that all natural resources law enforcement personnel meet the requirements for training and weapons qualification according to their experience and rank, and receive appropriate continuing education to enhance understanding of natural resources and ecosystem management.
	Enforce the natural resource laws and regulations of Fort Hood; conduct patrols adequate to cover the installation and prioritize them to ensure protection of sensitive resources; educate military personnel and the public about natural resource protection and how to report violations; file reports for all known violations and law enforcement actions.

3.16.2 Monitoring

Federal and state natural resource laws should be reviewed regularly, and pertinent or applicable changes should be considered for incorporation into Fort Hood’s regulations. In addition, incident reports should be reviewed to ensure that adequate actions have been taken in each instance and enforcement activities should be evaluated to determine their adequacy in protecting Fort Hood’s natural resources.

All law enforcement personnel should have their training and qualifications periodically reviewed (e.g., annually or semiannually) to ensure that training and performance meet current requirements.

3.16.3 Other Management Alternatives Considered

Fort Hood is a large, open installation that demands intensive vigilance and patrol to ensure compliance with all laws, regulations, and policies. Current Natural Resource Law Enforcement staffing levels are minimally sufficient to provide adequate protection. Because a less-intensive management approach to law enforcement would not afford a sufficient level of protection and compliance, this approach was not considered.

3.17 ITAM PROGRAM

Fort Hood Command's vision for the long-term sustainability of Fort Hood involves maintaining training areas that fully support mission requirements and sustain their resources. To achieve the vision, Fort Hood formed an Integrated Training Land Management (ITLM) committee to prepare an LSMP. The purpose of the Fort Hood LSMP is to implement an integrated land management and sustainment plan to guide the use, conservation, repair, protection, and long-term sustainment of Fort Hood training land resources. The plan integrates DPW (NRMB) and DPTS to support training requirements, land stewardship education, and training, as well as to incorporate environmental, cultural, and conservation management into the proactive sustainment of Fort Hood training land resources. In addition, the four components of the Fort Hood ITAM program–RTLA, LRAM, TRI, and SRA–are woven throughout the LSMP rather than being stand-alone programs.

According to the LSMP, the primary training land issues that concern the long-term sustainability of training and natural resources at Fort Hood include the following (Fort Hood, 2004b):

1. Tank trail network, trafficability, and erosion reduction
2. Protection and sustainment of endangered species while reducing training limitations
3. Protection and mitigation of eligible cultural sites while reducing training limitations
4. Hardening of stream crossings, trafficability, and erosion reduction
5. Hardening of hilltop access trails, trafficability, and erosion reduction
6. Erosion control structure construction and maintenance
7. Hardening of high-use staging/assembly areas
8. Critical land, unserviceable areas, and gully treatments to reduce erosion and improve maneuver
9. Vegetation reestablishment and maintenance
10. Brush management (juniper and mesquite)

11. Hardening of command/logistic (BSA) areas-Tactical Concealment Areas
12. Mulching of existing brush piles to open terrain to enhance maneuver
13 Firebreak network maintenance
14. RTLA monitoring of training land health
15. Sustainable Range and Environmental Awareness education/training and maps
16. Installation Maneuver Damage Program, education, and leadership emphasis
17. Regional prescribed burning
18. Repair or replacement of damaged or unserviceable infrastructure facilities
19. Grazing lease management
20. Noise education for the public
21. Oak wilt management

3.17.1 TRAINING LAND CONDITIONS

ITAM RTLA conducted several training land health and soil erosion studies on the west side of the installation. The Installation Status Report for FY 2001 through 2003 evaluated land conditions at C3 (i.e., majority of (> 60%) required facilities on hand meet majority on unit/activity needs; does not meet Army Standards; some functional deficiencies; impairs mission performance). Insufficient funds, increased training requirements, backlogged land repairs, erosion, bare ground (lack of vegetation), and new land damaged during training continue to degrade training land capabilities and conditions. Actions are needed to improve the installation land conditions before they degrade to C4 (i.e., less than 60% of required facilities on hand facilities do not meet unit/activity needs or Army Standards; major functional deficiencies; significantly impairs mission performance), which could severely affect Fort Hood's capabilities to conduct realistic training and vastly increase land rehabilitation costs (Fort Hood, 2004b).

The majority of land repair and sustainment work is programmed to occur under the Training Out Area Program (Fort Hood, 2004b). The intent of that program is to repair lands to improve readiness training, reduce erosion, promote vegetation growth, enhance training access, and shape unserviceable areas into usable areas that can sustain the training landscape. To balance training requirements and land repairs, the Western Training Lands have been divided into six sections, and each Out Area becomes the primary land repair area for the installation for a year. Training is deferred during the year an area is out to restore vegetation and ground cover. Cattle grazing is deferred until the latest forage assessments indicate adequate forage availability and the area is no longer scheduled for the out area land repairs and recovery of vegetation. With six out areas, each area is normally visited for repairs every 6 years. Priority land repair work can be required outside the Out Area Program. Figures

3-2 and 3-3 illustrate the training areas included in the Training Area Out Program in FY 2005 and FY 2006, respectively.

Funding drives the extent and volume of land repairs done to each out area. This is where repair work by DPW (NRMB) and DPTS (ITAM) is integrated to maximize funding and land resource repairs. Teamwork and the coordination of work reduce redundant work efforts and paperwork while making the most of the resources available to sustain the training lands.

Implementation of the management actions in the LSMP is divided into two categories: (1) short-range (through FY 2010) and (2) mid-range (FY 2000-2014) and long-range (FY 2015-2027). The goal of the short-range LSMP is to repair and enhance land resources. The projects expected to be conducted during this time frame are listed in Table 3-17. The location of RTLA plots and LRAM project sites are illustrated in Figure 3-4.

The mid-range and long-range LSMP will continue to sustain training requirements and the installation landscape from FY 2010 through FY 2027. Management initiatives slated for implementation from FY 2010 through FY 2027 to ensure the long-term sustainability of Fort Hood training lands include the following:

- Mitigation of cultural resource sites. Cultural resource sites inside the training lanes are protected and are worked only when the land is in the Training Out Area Program. Mitigation continues to maximize site recovery and removal from the eligible inventory.

- Public outreach programs to educate concerned citizens. Primary outreach topics include

    - Releasing studies that show no munitions are migrating from Fort Hood
    - Removing sediment from the mouth of Belton Lake to restore reservoir capacity
    - Removing sediment from erosion dams to prolong their lifespan to support water quality and quantity for drinking water
    - Protecting compatible land uses on adjacent lands to support FORCE XXI requirements, reducing mission restrictions associated with endangered species habitats in maneuver and live-fire training lands, and lessening the effects of noise and dust on the public.

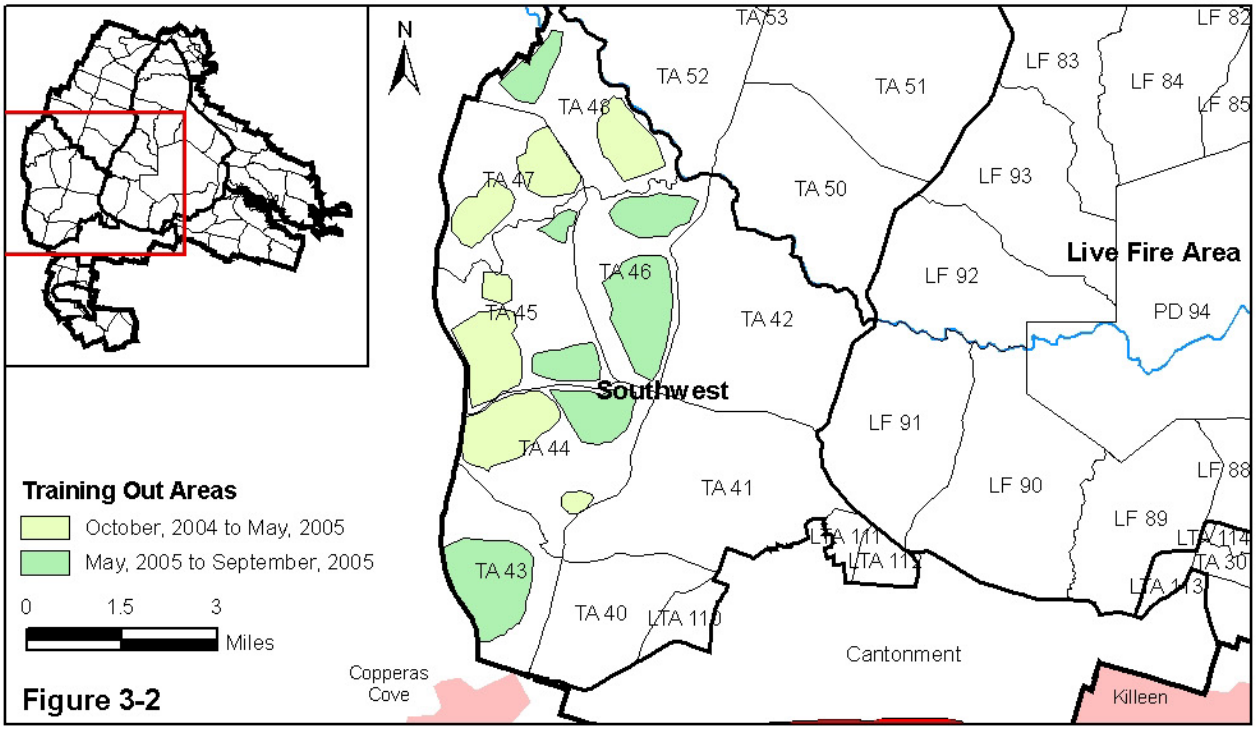


Figure 3-2

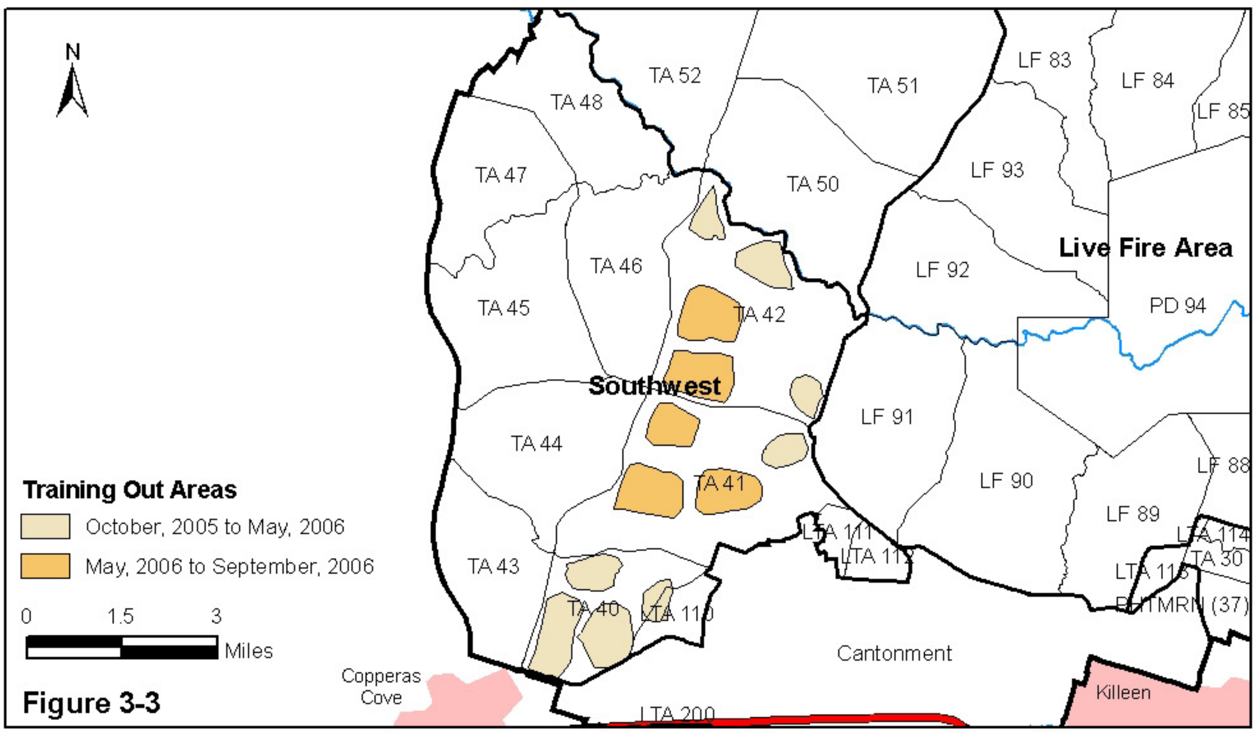
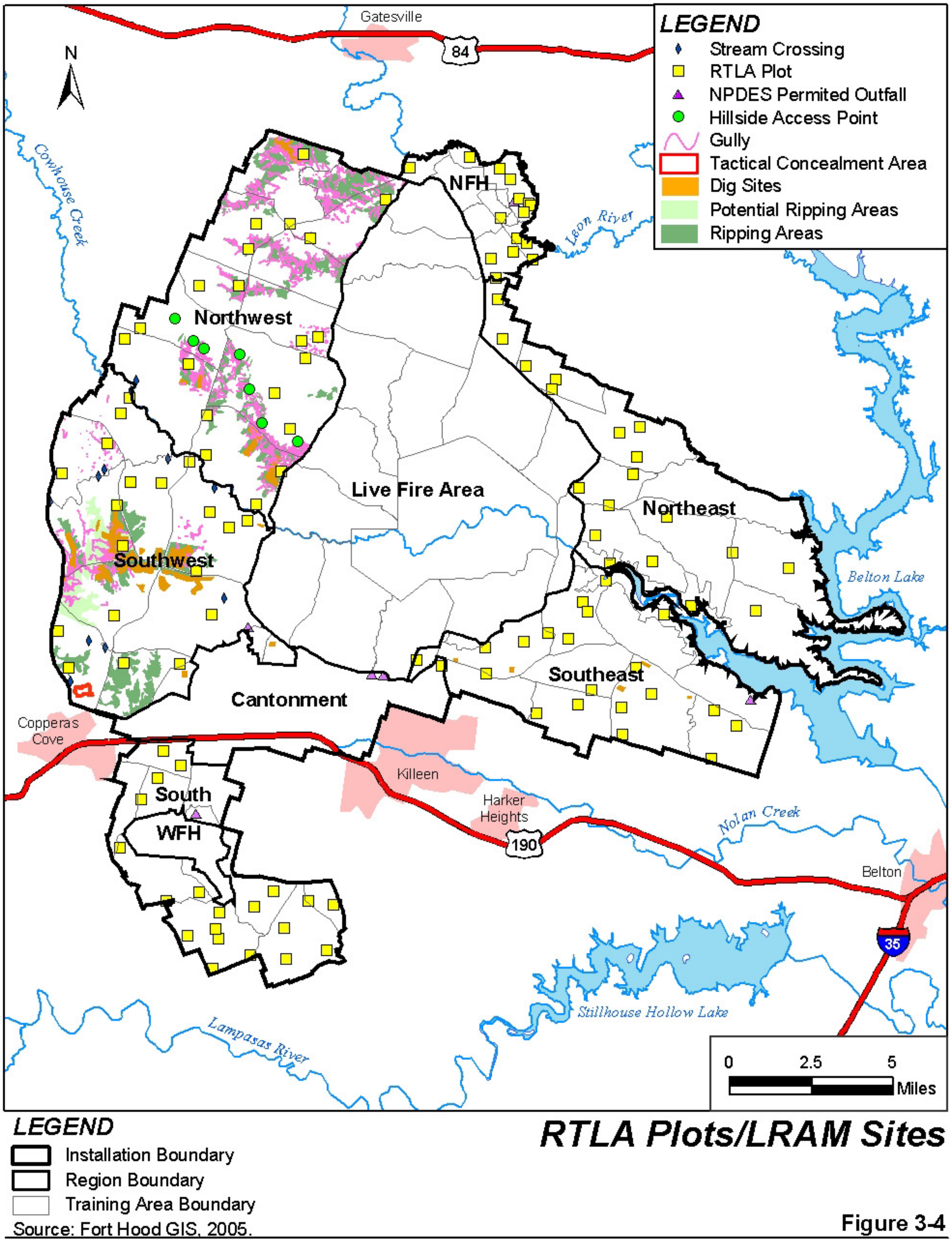


Figure 3-3

LEGEND
Installation Boundary
Region Boundary
Training Area Boundary
Source: Fort Hood GIS, 2005.

Training Out Areas Program, FY 2005 and 2006



RTLA Plots/LRAM Sites

Source: Fort Hood GIS, 2005.

Figure 3-4

Table 3-17
ITAM Project List

Project Type	FY 2006	FY 2007	FY 2008	FY 2009	FY 2010
CAP, cap/protect cult site from maneuvers	2	2	2	2	
CAT, critical area & gully treatment	1,843 acres	4,093 acres		1,000 acres	
CBT, combat trail network	10 miles	6 miles		6 miles	
ECS, erosion sediment control dam	1				
FBM, firebreak maintenance		50 miles	50 miles	50 miles	
FBT, firebreak trail					
HAT, hilltop access trail	50	11	18	12	
MLC, mulching			600 acres		
PLC, pipeline crossing	17	9		1	
RCA, river crossing abutment	2	2			
RCD, rock check dam				12	
SAT, staging area treatment	6	5	1	1	
TCA, tactical concealment area	2	1			
TDR, training damage repair	2,511 acres	1,640 acres	14,058 acres	5,100 acres	
VEG, vegetation/seeding	2,000 acres	2,000 acres	2,000 acres	2,000 acres	
XNG, stream crossing	25	14	38	48	
FHTM, Fort Hood training maps	30,000	30,000	30,000	30,000	
LCTA, Land Conditions Trend Analysis	120	120	120	120	
SRAM, Sustainable Range Awareness materials	10	10	10	10	
SRAV, Sustainable Range Awareness videos	1	1	1	1	
Total Cost	**$11.66 M**	**$11.75 M**	**$15.6 M**	**$12.43 M**	

Source: Fort Hood, 2004b.

- Use of conservation and ITAM resources to repair new maneuver land damage, minimize erosion, and reduce the repair backlog.

- Use of green bullets in live-fire training and use of simulators by training units during 50 percent of the yearly OPTEMPO. Unit training will require land half a year.

- Maintenance of trail networks to support future forces' combat vehicles.

- Environmental stewardship of military lands and stewardship and awareness education, which are part of the peacetime Army at Fort Hood. DPW integrates sustainable range awareness into environmental courses and classes. Environmental awareness and land stewardship education courses will be made available for soldiers, leaders, units, and senior commanders.

- Contaminated water and soils will be collected, processed and recycled back into the landscape.

SECTION 4.0: IMPLEMENTATION

4.1 ACHIEVING NO NET LOSS TO THE MILITARY MISSION

Section 101(b)(1)(I) of the Sikes Act states that each INRMP must, to the extent appropriate and applicable, and consistent with the use of the installation to ensure the preparedness of the Armed Forces, provide for "no net loss in the capability of military installation lands to support the military mission of the installation."

DoD policy stipulates that appropriate management objectives to protect the mission capabilities of installation lands (from which annual projects are developed) should be clearly articulated in the planning process and should be high in INRMP resourcing priorities. The effectiveness of the INRMP in preventing "net loss" must be evaluated annually. Mission requirements and priorities identified in the INRMP must, where applicable, be integrated into other environmental programs and policies. It is not the intent that natural resources are to be consumed by mission requirements, but sustained for the use of mission requirements. To achieve this, environmental programs and policies must have the goal of preserving the environment for the purpose of the mission.

There may be, however, instances in which a "net loss" is unavoidable because of the need to fulfill regulatory requirements other than the Sikes Act Improvement Act, such as complying with a Biological Opinion (BO) under the provisions of the Endangered Species Act (ESA) or the protection of wetlands under the provisions of the Clean Water Act (CWA).

No net loss in the capability of Fort Hood training lands to support the military mission is expected as a result of implementation of this INRMP.

4.1.1 Integrated Land Use and Natural Resources Decisions

Fort Hood continues to promote compatible multiple uses of its training lands by allowing grazing, hunting, fishing, and other outdoor recreational pursuits to occur in conjunction with military training. While allowing these ancillary uses of the training lands, Fort Hood must also ensure that the installation:

- Maintains the vegetative cover to prevent or minimize erosion, thereby ensuring the long-term sustainability of the training lands

- Protects and maintains the habitat necessary to meet its regional recovery goals for the black-capped vireo and golden-cheeked warbler
- Protects the karst habitat and the rare, endemic species inhabiting those environs
- Ensures compliance with the CWA by preventing degradation of its water bodies, which serve as drinking water sources and provide recreational opportunities

The integrated land uses mentioned above drive much of the funding and decision making process of the Natural Resources Management Branch (NRMB). Destruction of vegetation by tracked vehicles used during mechanized training is an unavoidable by-product of training and must be addressed so there is no loss of training lands or a decrease in tempo. In addition, Army regulations demand compliance with federal regulations, such as the Endangered Species Act and the Clean Water Act, and therefore resources must be put forth to ensure compliance with these and other federal laws and regulations. The expenditure of resources for these training land uses is a necessity.

Discretionary uses of the training lands, such as for grazing and outdoor recreation, are resourced by NRMB and subsidized by Fort Hood. Overuse of the training lands by cattle over time has resulted in degradation of the character and integrity of the rangeland vegetative communities, increased erosion rates, development of a gully network, and sedimentation of water bodies. NRMB and ITAM resources are expended to restore and maintain the rangeland/training areas to ensure no net loss of training. In addition, the cowbird control program that must be implemented per the Endangered Species Management Plan (ESMP) and BO, and funded by Fort Hood, is a direct result of the presence of cattle on the installation.

In addition to maintaining terrestrial and aquatic habitats, providing opportunities for hunting and fishing also requires Fort Hood to staff, fund, and train law enforcement officers, such as game wardens. During the hunting season, NRMB staff must man game check stations and collect harvest data. To ensure that mountain biking in the BLORA has no deleterious effect on nesting golden-cheeked warblers, NMRB has started to conduct routine surveys of the area.

Integrated land uses at Fort Hood and limited funding require that NRMB prioritize all management activities and funding decisions to ensure that the training lands are maintained and that the installation is in compliance with all applicable federal regulations.

4.2 SUPPORTING SUSTAINABILITY OF THE MILITARY MISSION

As stated in Section 1.2, the goal of the Fort Hood INRMP is to ensure that the natural resources located on the training lands are managed in such a way as to provide the optimum environment that sustains the military mission and provides the conditions required for realistic training. The management measures in this INRMP have been developed to successfully achieve the stated objectives necessary to meet this goal.

The overlap of similar management measures for different resource areas is indicative of the relationship that various components of an ecosystem have with one another. The need for integrated natural resources management is evident from the complexity of these relationships. For example, a significant portion of the training lands are either forests, woodlands, or grasslands. Forests and woodlands support the military mission by providing cover and the grasslands provide the open maneuver areas necessary for mechanized training, as well as the location of LZs and DZs. In addition to being essential for the military mission, the condition of the forests and grasslands directly influences the quality of wildlife habitat and, therefore, the condition and diversity of wildlife inhabiting Fort Hood. The condition of the vegetated watersheds also directly influences water quality, the condition of the fisheries, and sensitive habitats like the wetlands. These habitats are necessary to maintain or to increase the biodiversity at Fort Hood.

Managing forests, woodlands, and grasslands using an ecosystem approach will maintain, protect, and enhance natural resources. Furthermore, results from screening-level watershed and habitat assessments serve as indicators of the overall condition of natural resources. Degraded watershed and habitat conditions will result in loss of ecological integrity and biodiversity. Soil stabilization and revegetation LRAM projects conducted under the ITAM program ultimately improve the habitat conditions on a small scale and watershed conditions on a larger scale. The effects from these types of improvements reach beyond the particular area in which they are performed. Soil stabilization and revegetation stops erosion, decreases sediment loads to streams, lakes, ponds and wetlands and ultimately improves the habitat for the biological communities, including fish, inhabiting those waterbodies. Soil stabilization and revegetation also creates or improves habitat conditions for terrestrial wildlife species.

4.2.1 Impacts to the Military Mission and Sustainable Land Use

At Fort Hood, as at many U.S. military installations, security considerations and the need for safety buffer zones have limited access and created islands of biodiversity amid seas of ever-expanding residential and industrial development (TNC, 2005). This development encroaches on both the military mission and the biodiversity that the installations harbor. To address the problem of incompatible development or “encroachment,” Congress authorized DoD to partner with “eligible entities” (EEs) to create “buffers” in the vicinity of bases (section 2811 of the FY

2003 National Defense Authorization Act). The program is named the Readiness and Environmental Protection Initiative (REPI), but the Department of the Army refers to it as the Army Compatible Use Buffer (ACUB) program. DoD requested $20 million for the ACUB program in FY 2005, but non-governmental organizations like The Nature Conservancy, American Farmland Trust, and the International Association of Fish and Wildlife Agencies have been pressing lawmakers to fund the program at a higher level.

The military training mission at Fort Hood is impeded by several forms of encroachment, which DoD defines as "the cumulative result of any and all outside influences that inhibit necessary training and testing." The forms of encroachment affecting the mission at Fort Hood include regulatory encroachment, urban development, and the intrusion of livestock into the military training areas during live-fire exercises (TNC, 2005).

Regulatory encroachment involves the restrictions on training and the effort expended to comply with the provisions described in the ESMP and the BO for management of habitat for the black-capped vireo and the golden-cheeked warbler. However, recent revisions to the ESMP, which were approved by the March 2005 BO, permit the lifting of training restrictions associated with the change in endangered species habitat designation from core to non-core habitat in specific areas. Fort Hood is actively engaged in the ACUB program to evaluate the feasibility of acquiring conservation easements, purchase of development rights (PDR), or other long-term agreements on surrounding lands that will both provide an effective buffer to encroachment on the military training mission and have a high conservation value, such as lands that include habitat for endangered species. Efforts being pursued under the ACUB program should yield favorable long-term results by diluting the importance of endangered species habitat found on Fort Hood to the regional recovery of the black-capped vireo and the golden-cheeked warbler.

Like most military installations, Fort Hood is surrounded by increasing urban and suburban development. As such development occurs, there is increasing potential for conflict between urban residents or business interests and certain aspects of military training, which are not confined to Army property. For example, noise and smoke produced on Fort Hood might be detected in adjacent urban settings and deemed undesirable there.

Training stops when livestock wander into ranges and live-fire areas during live-fire exercises. Fencing training areas to prevent livestock from entering these areas would restrict military training even more than currently occurs and therefore is not an option. Actions being taken to manage livestock grazing to levels that minimally impede military training should reduce interruptions in training. In addition, limitations on the level of grazing permitted on the installation could be expected to improve training land conditions, thereby increasing training opportunities by decreasing the extent of training areas that need to be included in the Training Out Area Program.

4.3 FISH AND WILDLIFE CONSULTATION REQUIREMENTS

The Office of the Undersecretary of Defense (OUSD) has issued guidance for implementing the Sikes Act Improvement Act (SAIA), including requirements to consult with the U.S. Fish and Wildlife Service (USFWS) and state fish and wildlife agencies (DoD, 2005). That guidance is summarized below.

Section 101(a)(2) of the Sikes Act states that the INRMP must be prepared “in cooperation with” and reflect the “mutual agreement” of the USFWS and state fish and wildlife agency “concerning conservation, protection, and management of fish and wildlife resources.” The “old” Sikes Act §101(a)(1) “authorized,” but did not require, the Secretary of Defense to develop cooperative plans “mutually agreed upon” by the three parties. The new Sikes Act Improvement Act (SAIA) “requires” the Secretary of the Army to prepare INRMPs in cooperation with the other two parties and requires that the plans reflect “mutual agreement of the parties concerning the conservation, protection, and management of fish and wildlife resources” (DoD, 2005).

The new §101(a) language achieves a number of important objectives, including that mutual agreement should be the goal with respect to the entire plan. However, mutual agreement is required only with respect to those elements of the plan that are subject to the otherwise applicable legal authority (i.e., authority derived from a source other than the Sikes Act, such as the ESA) of the USFWS and state fish and wildlife agencies to conserve, protect, and manage fish and wildlife resources. Nothing in the SAIA is intended to either enlarge or diminish the existing responsibility and authority of the USFWS or state fish and wildlife agencies concerning natural resources management on military lands. Although it is not expected to occur often, where the USFWS or a state fish and wildlife agency withholds its agreement with an INRMP on the basis of objections to elements of the INRMP clearly not within the scope of the particular agency's authority, an installation may, notwithstanding the objections, finalize the INRMP and proceed to manage its natural resources in accordance with the terms of the plan.

Endangered Species Act Consultation. The Sikes Act has no requirements regarding the necessity for ESA consultation on INRMPs. DoD policy stipulates that in most cases INRMPs will incorporate by reference the results of an installation’s previous species-by-species ESA consultations, including any reasonable and prudent measures that might have been identified in an incidental take statement. Consequently, neither a separate biological assessment nor a separate formal consultation should be necessary concerning most INRMPs or INRMP revisions. Nonetheless, because the INRMP might include management strategies or other actions designed to balance the potentially competing needs of multiple species, listed or not, it could be prudent to engage in informal consultation with the USFWS during the INRMP revision process to confirm that such proposed actions will not affect listed species or designated critical habitat. If the INRMP does include management strategies or other actions that might affect listed species or designated critical habitat and these actions have not been the subject of previous consultations, Section 7 consultation on these actions will be necessary before they may be implemented.

***DoD Policy on Specific Coordination Requirements*.** In accordance with DoD policy guidance (DoD, 2005) each installation must do the following:

- Establish and maintain regular communication with the appropriate USFWS and state fish and wildlife agency offices to address issues concerning natural resources management that are not addressed in the INRMP. At a minimum, this communication must include annual coordination with all cooperating offices.

- Invite the USFWS and state fish and wildlife agency to participate cooperatively in the scoping, design, and preparation of the INRMP. Doing so will inform these offices about the DoD mission, invite them to consider solutions to difficult resource management problems, and expedite final INRMP coordination.

- Advise all appropriate internal and external stakeholders of the intent to prepare or revise an INRMP within 30 days of starting such an action. When providing this notification to USFWS and state fish and wildlife agencies, each DoD installation must concurrently request the USFWS and state fish and wildlife agencies to participate in the development or revision of the INRMP.

- Notify appropriate USFWS and state fish and wildlife offices of its intent to provide a draft INRMP for review and coordination at least 60 days before delivering the document.

For the USFWS, the appropriate office for initial contact by installations for the development and review of INRMPs is a field office. Pursuant to current USFWS Sikes Act guidance, a field office must review the INRMP and provide preliminary agreement concerning the conservation, protection, and management of fish and wildlife resources detailed in the INRMP prior to review in the regional office and final action by a Regional Director.

4.4 GIS MANAGEMENT, DATA INTEGRATION, ACCESS AND REPORTING

Efficient data collection, storage, management, and analysis are essential for conducting a comprehensive natural resource management program, especially at Fort Hood given the size of the installation and the scope of activities. A geographic information system (GIS) is a particularly useful tool for evaluating the relationship between various natural resource management activities and the military mission. Global Positioning System (GPS) technology allows the field staff to accurately map geographic features and to delineate various habitats in the field or to mark the exact location of a resource, such as a cave opening.

Since the previous INRMP, Fort Hood has upgraded its GIS from GRASS to the more robust ArcInfo system. TNC provides GIS support for the NRMB under a 5-year cooperative agreement. G3 Range Division provides GIS support for the ITAM program.

GIS databases and map coverages can serve as a powerful management tool for facilitating the integration and implementation of the resource-specific management measures presented in this INRMP. An overlay of the coverages for the natural and cultural resource areas can graphically illustrate the complexity of the environment and provide the means to readily identify and resolve potential conflicts between natural resource issues and mission requirements.

4.5 TRAINING OF NATURAL RESOURCE PERSONNEL

DoD Instruction 4715.3 states that “Necessary supplemental training to ensure proper and efficient management or protection of natural resources shall be provided quickly.” Any new natural resource law enforcement officers hired at Fort Hood will qualify with personal sidearms twice annually and shotguns annually. Officers will have a minimum of 40 hours of refresher training annually.

NRMB will send at least one person to each of the following annual workshops or professional conferences as appropriate (dependent on availability of funding):

- International Erosion Control Association
- National Military Fish and Wildlife Association annual workshop
- American Society of Agronomists annual meeting
- North American Natural Resources Conference

- Southeastern Association of Fish and Wildlife Agencies
- ITAM Workshop
- The Wildlife Society Conference
- ArcView Users Conference
- American Fisheries Society Annual Workshop
- Society for Range Management

Other conferences and workshops will be evaluated for their usefulness, and decisions will be made based on the relevance to ongoing projects and funding availability. Meetings that are especially useful include AOU workshops, RTLA advanced training, GIS basic and advanced training, turkey symposia, white-tailed deer symposia, Watchable Wildlife workshops, wetlands training, and endangered species training.

Personnel will be trained in related environmental fields. NEPA training will be required of all supervisory personnel, as well as others who review or prepare NEPA documents. Any new natural resource law enforcement personnel hired will be required to attend spill response and historic resources enforcement training.

4.6 ORGANIZATIONAL ENHANCEMENT, ROLES, AND RESPONSIBILITIES

The ecosystem approach described in this INRMP to manage the natural resources of Fort Hood can be implemented by the installation's existing organization. The NRMB has the primary role and responsibility for the implementation of this INRMP, which addresses the period from FY 2006 through FY 2010. No changes of organization are expected, or necessary, to implement this INRMP.

4.6.1 Staffing

Fort Hood has the core staff of professionally trained natural resources management personnel necessary to implement this INRMP. As mentioned in Section 1.3.7, Fort Hood NRMB receives assistance through a cooperative agreement with TNC. The personnel that currently constitute the natural resources management staff at Fort Hood, including TNC personnel, are listed in Table 4-1.

Table 4-1
Fort Hood Natural Resources Management Staff

Permanent, Full-time Personnel		
Number	**Position**	
Fort Hood NRMB Staff		
1	Supervisory Wildlife Biologist (Army civilian)	
1	Agronomist (Army civilian)	
3	Wildlife Biologist (Army civilian)	
1	Wildlife Biologist (contract)	
1	Entomologist (Army civilian)	
1	Entomologist Assistant (contract)	
1	Soil Conservationist (Army civilian)	
1	Outreach Coordinator (contract)	
2	Land Management Specialist (contract)	
TNC Staff		
1	Director, TNC	
1	GIS Technician	
2	Field Biologist	
1	Field Biologist/Fire Technician	
1	Publication Specialist	
1	Vegetation Ecologist	
2	Conservation Biologist	
1	Administrative Assistant	
3	Heavy Equipment Operators	
Seasonal, Part-time Personnel		
Number	**Resource Focus**	**Average Months Worked/Year**
12	Golden-cheeked warbler	4.7
9	Black-capped vireo	4.5
11	Botany	3.1
6	Prescribed Fire	6.0
1	Fire Ant Control	3.0
1	Feral Hog Trapping	6.0
1	Sign Post Maintenance	3.5
1	Data Entry	6.0

Additional sources of temporary labor, hired with term limitations, include seasonal employees (NRMB and TNC), university hires, and outside agency reimbursable hires. However, the natural resources management professionals currently in-house provide the foundation and fulfill the managerial roles necessary to continue the successful natural resources program at Fort Hood.

4.6.2 Outside Assistance

Implementation of a number of the projects discussed in this INRMP will require active outside assistance. This assistance, which is described as needed in Section 1.0, will come from state and federal agencies, private consortiums and organizations, universities, and contractors. Using these resources is the most efficient and cost-effective method for acquiring expertise on a temporary basis. Some of the parties will be reimbursed for their assistance, as agreed upon in Memoranda of Understanding (MOUs) and contractual agreements, whereas others will supply their assistance in accordance with cooperative agreements.

4.7 ANNUAL REVIEW AND MANAGEMENT PERFORMANCE EVALUATION

Section 101(b)(2) of the Sikes Act [16 U.S.C. 670a(b)(2)] states that each INRMP "must be reviewed as to operation and effect by the parties thereto on a regular basis, but not less often than every 5 years." Per DoD policy, the requirement to "review" the INRMPs regularly does not mean that every INRMP necessarily needs to be revised. The Sikes Act specifically directs that the INRMPs be reviewed "as to operation and effect," emphasizing that the review is intended to determine whether existing INRMPs are being implemented to meet the requirements of the Sikes Act and contribute to the conservation and rehabilitation of natural resources on military installations (DoD, 2005).

DoD policy requires installations to review INRMPs annually in cooperation with the other parties to the INRMP. Annual reviews facilitate "adaptive management" by providing an opportunity for the parties to review the goals and objectives of the plan, as well as to establish a realistic schedule for undertaking proposed actions (DoD, 2005).

Installations will likely find it useful to memorialize these less formal reviews through an exchange of letters or a jointly executed memorandum. These documented annual (or otherwise) reviews might be useful in developing the *ex parte* reports required by Section 101(f) of the Sikes Act. They might also expedite—or, in appropriate cases, substitute for—the more formal 5-year reviews, provided the "regular" reviews are reasonably comprehensive and the written documentation evidences the parties' mutual agreement.

SECTION 5.0: ENVIRONMENTAL CONSEQUENCES

This section of the document assesses known, potential, and reasonably foreseeable environmental consequences related to implementing the INRMP and managing natural resources at Fort Hood. Section 5.1 addresses implementation of the no action alternative, which reflects the continuation of existing baseline conditions as described in Section 2.0. Section 5.2 presents potential effects in the context of the scope of the proposed action and in consideration of the affected environment. This assessment is organized by resource area and considers implementation of the selected management measures in their entirety (as presented in Section 3.0 and Prescriptions). Certain environmental resources and conditions that the Army normally evaluates in an Environmental Assessment (EA) would not be affected by the proposed action. Section 5.3 identifies these environmental resources and conditions and presents the reasons for their not being examined in detail. Cumulative effects are discussed in Section 5.4. Implementing the proposed action is Fort Hood's preferred alternative. A summary of the potential environmental consequences associated with the no action alternative and the proposed action is presented in Section 5.5.

As discussed in Section 1.9.5, *Description of the Proposed Action and Alternatives*, the EA addresses two alternatives—the proposed action and the no action alternative. Other management alternatives were considered during the screening process but eliminated because they were economically infeasible, ecologically unsound, or incompatible with the requirements of the military mission. Section 3.0, *Future Management*, provides a description of the goals and objectives used to develop management prescriptions and the rationale for why certain management measures were selected. Therefore, the analytical framework supporting each resource area is not repeated in this section. This approach supports Army guidance for concurrent preparation and integration of the INRMP and National Environmental Policy Act (NEPA) documentation.

As discussed in Section 1.9.5, the Fort Hood INRMP is a "living" document that focuses on a 5-year planning period based on past and present actions. Short-term management practices included in the plan have been developed without compromising long-range goals and objectives. Because the plan will be modified over time, additional environmental analyses might be required as new management measures are developed over the long term (i.e., beyond 5 years).

5.1 NO ACTION ALTERNATIVE

Adoption of the no action alternative would mean that Fort Hood's 5-year INRMP update (this INRMP) would not be implemented and current natural resource management practices at Fort Hood would continue "as is." Existing conditions and management practices presented in Section 2.0, *Current Conditions and Use*, would continue and no new initiatives would be established.

Potential consequences associated with the no action alternative are discussed in this section for each resource area described in Section 2.0, *Current Conditions and Use*. Section 5.4 summarizes the analysis of potential consequences for the no action alternative and compares them to the proposed action. As shown, no significant or adverse effects would be expected. Under the no action alternative, the environmental conditions at Fort Hood would not benefit from the management measures associated with implementing the proposed INRMP.

Expected consequences of the no action alternative for each resource area are presented in the following paragraphs.

Land Use. Moderate adverse effects would be expected. Without pursuit of the ACUB program as proposed in the INRMP, urban sprawl could be expected to continue along Fort Hood's borders resulting in further encroachments on the military mission.

Soils. Moderate adverse effects would be expected. The current INRMP does not include a comprehensive soil resource management program that minimizes and, when necessary, mitigates erosion and sedimentation at Fort Hood. The LRAM program would continue to identify and repair sites where erosion has been determined to be a problem; however, potential adverse effects from overuse of the training areas by cattle would not be adequate to address the current erosion rates.

Water Resources. Moderate adverse effects would be expected. The current INRMP does not establish a formal plan of action for monitoring and protecting the water resources, nor does it include watershed protection measures, nonpoint source pollution controls, and a comprehensive monitoring program designed to identify water quality problems at their onset.

Wetlands. Moderate adverse effects would be expected. The no action alternative does not provide a formal plan for identifying, evaluating, and monitoring wetland habitat conditions, nor does it establish formal protection measures to prevent or minimize impacts that could result from training and other mission-related activities. In addition, the no action alternative does not include the implementation of comprehensive soil resource monitoring, conservation measures, or a plan of action to minimize existing, or prevent future, soil erosion and sedimentation problems affecting wetlands on Fort Hood. Lack of a comprehensive soil conservation and management plan could result in adverse impacts on wetlands. Also, the no action alternative does not establish limited-use wetland buffers to protect water quality by reducing nonpoint source impacts associated with runoff and adjacent land uses.

Aquatic Habitat. Moderate adverse effects would be expected. Because Fort Hood has undertaken needed planning efforts (i.e., efforts prior to the implementation of the INRMP, such as road upgrades, gully plugs, and other efforts conducted through programs like the LSMP and ITAM programs) that indirectly might have mitigated future significant adverse impacts, the effects of the no action alternative might now be characterized as moderate. However, the no action alternative does not provide for the implementation of routine habitat assessments and monitoring programs. Implementation of such programs not only would provide a method for protecting these habitats but also would provide a baseline of data that could be used to prioritize projects and identify the most efficient allocation of resources. In addition, the no action alternative does not establish management measures to further protect and enhance these habitats by preventing or minimizing potential impacts such as sedimentation. Sedimentation of the surface waters on Fort Hood limits and in some cases might eliminate viable fish spawning areas. Furthermore, adverse effects on the aquatic habitat in the lakes would continue under the no action alternative. Currently, there are no actions or controls in place to monitor aquatic vegetation and invasive aquatic species. Without these controls, uncontrolled aquatic vegetation growth could limit the potential of the recreational fisheries and decrease the overall ecological condition of the aquatic environments of Fort Hood.

Terrestrial Habitat. Moderate adverse impacts would be expected. Under the no action alternative, there would be no formal plan of action to improve and maintain terrestrial habitat conditions and diversity, resulting in a continued challenge for Fort Hood to maintain or improve overall biodiversity. The no action alternative would result in habitats that are not desirable for military training. Furthermore, under the no action alternative, there would be no coordinated effort or plan to create or maintain the quality of habitat attractive to or required by a diverse population of wildlife. Under the no action alternative, the health and condition of the plant communities on Fort Hood would not be improved.

The current collection of management practices would not be expected to cause significant impacts on floral species because it involves no change in current activities. Recent trends in the reduction of unique native warm season grasses due to successional pressures would continue. These successional pressures have been impeded by current management practices (e.g., prescribed burning); however, increases in woody growth coverage and edge encroachment would continue to occur. Thus, thick stands of Ashe juniper would continue to overtake open areas. The decline in habitat quality and complexity would continue to adversely affect biodiversity.

The spread of exotic weeds on Fort Hood is a recognized problem, and exotic species have been recorded as part of the basic inventory work. The status quo alternative has few aggressive measures to remove or prevent the spread of exotic species, and compliance monitoring is not designed to determine the effectiveness of management practices. The current reactive approach to vegetation management has allowed several exotic species to become established, and more exotics would be expected to become established and degrade the natural biodiversity in the future under this alternative.

Fish and Wildlife. No effects would be expected. Current resource management measures would be expected to continue to maintain and potentially increase the abundance and biodiversity of wildlife, protect and enhance wildlife habitats (aquatic, riparian, wetland, and terrestrial), and increase the quality and complexity of the habitat.

Endangered, Threatened, and Rare Species. No effects would be expected. The current management of federally listed endangered species would continue in accordance with the Fort Hood ESMP and the Biological Opinion issued by USFWS in March 2005.

Cultural Resources. Long-term minor adverse effects on cultural resources would be expected from the no action alternative and a continuation of existing management strategies and environmental circumstances. Potential adverse impacts on cultural resources in the training areas at Fort Hood are comparable to those at military installations with substantial training missions and might result from maneuver damage from tracked vehicles and wheeled vehicles, vandalism or looting of historic structures or archaeological sites, earth-moving activities, explosive ordinance, and natural processes of erosion that might be exacerbated by the activities described above (Fort Hood, 2001c). Cultural resources would continue to be administered by the Cultural Resource Manager, as outlined in the Integrated Cultural Resources Management Plan (ICRMP), but the no action alternative could result in a lesser degree of integration of cultural resource concerns, information exchange, and cultural resource goals with those of the Natural Resources program, including integration of relevant planning processes for forthcoming and continuing projects. This could result in disturbance of significant cultural resources, such as archaeology sites. A joint effort on the part of many Fort Hood Directorates and their divisions has been and is required to sustain the environmental conditions necessary for the readiness training of soldiers in a realistic setting, while at the same time protecting the ecological and biological integrity of the natural setting and the integrity of the cultural resources within the boundaries of the installation.

In summary, analysis of the existing (baseline) conditions identifies no serious environmental concerns. However, the previous INRMP (2001 – 2005) was never fully approved by all parties and therefore does not provide the mechanisms to address the need for or the outcome of a variety of management actions. In addition, AR 200-3 requires installations to conduct a major revision of "all parts" of their INRMPs every 5 years. The 5-year period for the proposed INRMP expires at the end of FY 2010. Therefore, implementation of the no action alternative is not favored.

5.2 PROPOSED ACTION (PREFERRED ALTERNATIVE)

The potential consequences associated with the proposed action are discussed in this section for each resource area described in Section 3.0. Section 5.5 summarizes the potential consequences of the proposed action and compares them with the consequences of the no action alternative (baseline or existing conditions). Implementing the INRMP would result in no effects or beneficial effects on the resource areas. Compared to the no action alternative, environmental conditions at Fort Hood would improve as a result of implementing the proposed INRMP. Therefore, the proposed action is the preferred alternative.

Expected consequences of the preferred alternative for each resource area are presented in the following paragraphs.

Land Use. Beneficial effects would be expected. Under the proposed action, Fort Hood would continue to pursue and implement an effective ACUB, which would limit urban sprawl and reduce potential encroachments on the military mission.

Soils. Beneficial effects would be expected. By implementing the comprehensive soil resource management program, impacts on soils associated with erosion and sedimentation on Fort Hood would be minimized. As part of the proposed action, existing sites where erosion has been determined to be a problem would be addressed through the LRAM component of the ITAM program and the Training Out Area Program. In addition, monitoring soil conditions to identify potential problem areas, implementing conservation measures, improving the type and area of vegetative cover, managing cattle grazing, and, when possible, avoiding activities likely to result in erosion would minimize potential impacts on the soil resource and result in a reduction in erosion at Fort Hood.

Water Resources. Beneficial effects would be expected. Implementing a comprehensive sampling and assessment plan and developing a database would allow Fort Hood to readily track the status and trends of water and habitat quality in the training areas and provide a methodology for evaluating the effectiveness of best management practices (BMPs). The proposed action also facilitates the identification of problem areas with high erosion and sedimentation and establishes protective riparian buffer zones to prevent degradation of water resources and aquatic habitats.

Wetlands. Beneficial effects would be expected. Implementation of the proposed action would protect wetlands by providing a basis to evaluate and monitor habitat conditions through the development of a wetland database and management plan for Fort Hood. Establishing buffers would minimize potential impacts on wetlands associated with adjacent activities. Additional efforts would be made to reduce impacts on wetlands by planning mission activities, when possible, in a manner consistent with wetland protection objectives. Where current activities might be affecting wetland functions, efforts would be made to identify the types and sources of impacts; where applicable, restoration of affected habitats would be implemented.

Aquatic Habitat. Beneficial effects would be expected. The assessment of aquatic habitats at Fort Hood would provide a basis for developing a management program that would both protect and enhance these habitats on the installation. Assessment of aquatic habitats would also provide a baseline that could be used in tracking the conditions and trends of these habitats, which would allow management practices to be applied where and when needed. The establishment of riparian buffers around surface water bodies at Fort Hood would provide protection to habitats both in and adjacent to the resource. Where impacts on aquatic habitats occur as a result of mission activities, management objectives would provide for the timely mitigation of the impacts. Beneficial effects could be expected as a result of the development of a plan to monitor and control aquatic vegetation before it becomes a significant problem.

Terrestrial Ecosystems. Beneficial effects would be expected. From the perspective of habitat, implementation of the proposed action would result in improved terrestrial habitat conditions for wildlife because maintaining a high level of habitat diversity is a priority of the INRMP. Implementation of the proposed action would result in improved habitat conditions, expansion of unique native warm season species, and control of nonnative invasive species at Fort Hood.

Fish and Wildlife. All the projects composing the proposed action are designed to mimic or enhance natural processes and would be expected to enhance fish and wildlife resources in general. There is a high potential for beneficial results from these management activities. The proposed action would provide management of fish and wildlife resources at Fort Hood on an integrated basis. The INRMP uses an ecosystem management strategy to achieve biological diversity while emphasizing the use of native species for restoration activities. The programs incorporated into various management plans under this INRMP include protection from wildfires, monitoring of a variety of plants and animals, and minimization and repair of damage to habitats from training activities.

Endangered, Threatened, and Rare Species. Beneficial effects on all federally listed endangered species at Fort Hood would be expected. Current natural resource management practices do, however, meet the minimum requirements of the ESA and adequately limit "take" within the limits coordinated with the USFWS. Implementation of the proposed action would provide additional and expanded protection and management for these species. Furthermore, these species would be treated with added importance and valued for their contributions to the unique natural heritage of Fort Hood.

An emphasis on mechanical, cultural, biological, and limited chemical pest management techniques would reduce the overall probability that threatened or endangered species are harmed, directly or indirectly, by invasive exotic species. Use of the pest management techniques outlined in the integrated pest management guidance would be expected to protect sensitive species in and around specific project sites. No pest management operation that has the potential to adversely affect endangered or protected species or their habitats would be conducted without prior coordination with the USFWS. Actions for natural resource management under this alternative would be more reactive than proactive and would be expected to allow more impacts than the other alternatives.

Cultural Resources. Beneficial effects on the cultural resources at Fort Hood would be expected. The primary concern regarding resources pertains to protecting prehistoric and historic sites within the boundaries of Fort Hood. Implementation of the proposed action provides for consultation and coordination with the Cultural Resources Manager prior to the initiation of any activity that might affect historic or cultural resources. The purpose of the consultation is to determine whether historic or cultural resources are in close proximity to the proposed activity and whether the activity would have the potential to adversely affect those resources. Under the proposed action, the probability of disturbing potential cultural resources, including those identified between implementation of the original INRMP and this revised version, would be greatly reduced. The placement of a bat gate over the Zints Mine entrance has cultural resources implications; however, the gate could provide additional protection for the mine as well.

The EA findings are consistent with the goals of the natural resources management program to ensure the long-term sustainability of desired military training area conditions; to maintain, protect, and improve ecological integrity; to protect and enhance biological communities, particularly sensitive, rare, threatened, and endangered species; to protect the ecosystems and their components from unacceptable damage or degradation; and to identify and restore degraded habitats. The management measures recommended by the INRMP, if implemented, would directly and positively affect the health and condition of natural resources at Fort Hood.

5.3 RESOURCE AREAS NOT EXAMINED IN DETAIL

This is a "focused EA," consistent with guidance issued by the Council on Environmental Quality (CEQ) at 40 CFR 1501.7(a)(3). In considering environmental and socioeconomic resources and conditions, the Army has determined that certain resources would not be affected by either the proposed action or no action alternative and, therefore, do not need to be evaluated in detail. The following resources would not be measurably affected by the proposed action or the no action alternative.

Facilities. No effects would be expected. All facilities would continue to be maintained and operated in accordance with required permits and capabilities of the systems. Under the proposed action, the demand for utilities and roads would not be expected to increase and therefore would not adversely affect existing facilities.

Air Quality. No effects would be expected. The primary concern regarding air quality and potential environmental effects pertains to increases in pollutant emissions; exceedances of National Ambient Air Quality Standards and other federal, state, and local limits; and impacts on existing air permits. Potential effects on existing pollutant emissions are precluded by the fact that the proposed action does not involve any activities that would contribute to changes in existing air quality. Therefore, there would be no effects regarding air quality as a result of implementing the proposed action.

Noise. No effects would be expected. The primary concern regarding noise and potential environmental effects pertains to increases in sound levels, exceedances of acceptable land use compatibility guidelines, and changes in public acceptance (i.e., noise complaints). However, potential effects are precluded by the fact that the proposed action does not involve any activities that would affect noise conditions. Therefore, there would be no effects regarding noise levels or sound quality as a result of implementing the proposed action.

Hazardous and Toxic Materials. No effects would be expected. All hazardous and toxic materials would continue to be handled in accordance with federal laws and Army regulations, including the Resource Conservation and Recovery Act (RCRA), the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), the Toxic Substances Control Act (TSCA), and AR 200-1. Thus, no adverse effects regarding the generation of hazardous and toxic materials would be expected under the proposed action.

Socioeconomic Resources. No effects would be expected. The proposed action would not involve any activities that would contribute to changes in population, housing, industry earnings and employment, or personal income.

Environmental Justice. No effects would be expected. Implementation of the proposed action would not create any advantage or disadvantage for any group or individual and would not create disproportionately high or adverse human health or environmental effects on children or minority or low-income populations at or surrounding Fort Hood.

5.4 CUMULATIVE EFFECTS

In 40 CFR 1508.7, the CEQ defines *cumulative effects* as the “impacts on the environment which result from the incremental impact of the action when added to other past, present, and reasonable foreseeable future actions regardless of what agency (federal of nonfederal) or person undertakes such other actions.”

Seven actions on and near Fort Hood warrant identification:

- *Residential Communities Initiative Program.* In 2001 Fort Hood transferred operational management of its on-post family housing to a private sector developer. The transaction has led to demolition, renovation, and construction to provide an end state inventory of more than 6,200 family housing units.
- *Joint Use.* In August 2004 the installation’s Robert Gray Army Airfield entered joint use service with the City of Killeen.
- *Urban Assault Course.* Fort Hood recently approved construction of an urban assault course, shoot house, and associated support facilities on the east side of West Range Road within the restricted live-fire area. The new facilities will support training of personnel in environments that simulate anticipated 21st century combat scenarios.
- *Digitization of Ranges.* In ongoing projects, Fort Hood continues to digitize existing ranges to enhance realism and improve scoring accuracy so that soldiers can obtain greater benefit from their training. A recent proposal includes digitization of aerial ranges for use by rotary-wing aircraft stationed at Fort Hood.
- *Road Improvements.* In addition to the tactical vehicle road that is part of the proposed action, three pending road projects would benefit traffic flow at the post and in adjacent municipalities: (1) extension of State Highway 195 and establishment of a new Control Access Point to divert traffic from on-post residential areas during peak hours; (2) widening of Tank Destroyer Boulevard to four lanes from Clear Creek Road to Clark Road and establishment of a single commercial cargo entrance at Clark Road and US Highway 190, as well as the proposed addition of a reliever route on US 190 in Copperas Cove; and (3) improvements providing for an

overpass/cloverleaf or widening of Clear Creek Road and State Highway 201 for travelers to Killeen-Fort Hood Regional Airport.

- *Sanitary Sewer Lift Station.* To meet growing use of North Fort Hood as a training area and billeting cantonment for Reserve Component forces, Fort Hood proposes to construct a lift station to pump wastewater to the Gatesville treatment plant.
- *Texas A&M University Campus.* Legislation pending in Congress would authorize Fort Hood's transfer of approximately 672 acres to the Texas A&M University System for development of a campus to serve 20,000 students. The essentially undeveloped land in the southeastern portion of West Fort Hood, in Training Area 27, is along State Highway 195, southeast of Robert Gray Army Airfield.

In addition to the above-mentioned projects, Fort Hood is undergoing transformation to modularity, as well as gaining more troops. These anticipated changes in training can be expected to result in an increase in the intensity and frequency of the training that occurs on the installation.

USFWS has recognized that Fort Hood is critical to the recovery of the black-capped vireo and the golden-cheeked warbler. Fort Hood has taken and continues to take steps toward expanding off-site conservation and protection of these species by partnering with habitat management projects on private lands; funding permanent conservation easements and long-term Safe Harbor agreements through TNC and Environmental Defense; and evaluating the feasibility of participating in DoD's ACUB program. The premise behind these activities is to offset the potential effects of mission activities on the breeding populations of these avian species, as well as limiting potential new sources of encroachment on the military mission. A potential future challenge is that Fort Hood's karst habitats are home to karst/cavernicole species that are endemic to Fort Hood. Because Fort Hood is the only location currently known for these rare species, it is possible that the species could become candidates for listing under the ESA. This could then lead to imposed restrictions on training activities at Fort Hood.

Implementation of the INRMP would result in a comprehensive environmental strategy for Fort Hood that represents compliance, restoration, prevention, and conservation; improves the existing management approach for natural resources on the installation; and meets legal and policy requirements consistent with national natural resources management philosophies. Over time, adoption of the proposed action would enable Fort Hood to achieve its goal of maintaining ecosystem viability and ensuring the sustainability of desired military training area conditions.

Fort Hood can be viewed as an island of generally stable, well-managed natural systems surrounded by areas of varying levels of growth and development. Although growth and development can be expected to continue in the areas surrounding Fort Hood, the environmental effects, although possibly adversely affecting natural resources within the ecoregion, would not be expected to result in cumulatively adverse effects on these resources when added to the effects of activities associated with the proposed management measures contained in the INRMP.

5.5 SUMMARY OF POTENTIAL ENVIRONMENTAL CONSEQUENCES

Implementation of the INRMP would be expected to provide long-term beneficial effects on the existing environmental conditions at Fort Hood (Table 5-1).

Table 5-1
Summary of Potential Environmental Consequences

Resource Area/Environmental Condition	Environmental Consequences	
	No Action	**Proposed Action**
Land Use	Moderate adverse effects	Beneficial effects
Soils	Moderate adverse effects	Beneficial effects
Water Resources	Moderate adverse effects	Beneficial effects
Wetlands	Moderate adverse effects	Beneficial effects
Aquatic Habitat	Moderate adverse effects	Beneficial effects
Terrestrial Habitat	Moderate adverse effects	Beneficial effects
Fish and Wildlife	No effects	Beneficial effects
Endangered, Threatened, and Rare Species	No effects	Beneficial effects
Cultural Resources	Minor adverse effects	Beneficial effects
Facilities	No effects	No effects
Air Quality	No effects	No effects
Noise	No effects	No effects
Hazardous and Toxic Materials	No effects	No effects
Socioeconomic Resources	No effects	No effects
Environmental Justice	No effects	No effects
Cumulative Effects	Adverse effects	Beneficial effects

SECTION 6.0:
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APPENDIX A

Land Sustainment Management Plan (LSMP)

Sustainable Training Areas

Land Sustainment Management Plan

Revised 9 Sep 04

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INTRODUCTION to the Land Sustainment Management Plan (LSMP)

The Jun 02 Sustainment Conference culminated in the Garrison Commander's vision for sustaining the installation and a primary goal for the Sustainable Training Land group. The vision end state was training areas that fully support mission requirements and sustain resources. This end state was represented by five sub-goals.

1) Mitigate 100 archeological sites without impacting training by 2027.
2) Recover (de-list) threatened and endangered species by 2027.
3) Resolve all encroachment issues by 2027.
4) Eliminate risk from contaminants on training lands and ranges by 2027.
5) Reduce and maintain soil erosion levels at accepted soil loss tolerance standards on training lands by 2012.

To achieve the intent of the vision, an installation land sustainment committee (Integrated Training Land Management (ITLM)) was formed to expand and define the Fort Hood land sustainment issues with focus towards

1) Identifying the sustainment issues
2) Selling strategies to sustain Fort Hood
3) Neutralizing or bypassing resistors, to include changing policies and procedures
4) Execution of strategies to sustain Fort Hood, providing long term survival for Fort Hood, and procurement of funds to support Hood land sustainment

This document is the work of the ITLM committee to define the land issues, goals, and sustainment concerns into a Land Sustainment Management Plan (LSMP) for implementation to improve and sustain Fort Hood Training Lands. NEPA documentation may be required for this plan and should be documented as part of the Installation Sustainability Plan.

This document is the next section of the Jun 02 Training Areas Sustainability Booklet and should be incorporated into the back of the booklet. This is the installation short range Land Sustainment Management Plan (LSMP).

EXECUTIVE SUMMARY

PURPOSE

The purpose of the Fort Hood Land Sustainment Management Plan (LSMP) is to implement an integrated land management and sustainment plan to guide the use, conservation, repair, protection, and long-term sustainment of Fort Hood training land resources. This plan integrates DPW and DPTS agencies to support training requirements, land stewardship education, and training, environmental, cultural, and conservation management into the proactive sustainment of Fort Hood training land resources.

This plan incorporates the Integrated Natural Resource Management Plan (INRMP, draft), the Cultural Resource Management Plan (CRMP, draft), the Range and Training Land Program (RTLP), Endangered Species Management Plan (ESMP), Real Property infrastructure maintenance, Master Planning of facility and range modernization and the Integrated Training Area Management (ITAM) Program short range workplan.

SCOPE

The focus of the LSMP is on the sustainment and management of the installation training land resources. Training lands, for this plan, are the lands and ranges outside of the cantonment/garrison areas where military training, operations, and readiness exercises are or will be conducted. This plan applies to land managers and all land users of the installation's training lands: military, governmental and nongovernmental agencies, and the public.

RELATIONSHIP TO MILITARY MISSION

LSMP supports the primary mission of Fort Hood which is to train, sustain, and promote the survivability of soldiers for worldwide deployment and Army readiness mission accomplishment while sustaining the installation's training land resources. The LSMP enhances training while integrating environmental compliance, land conservation, and repairs to sustain Fort Hood environment, ecosystem and realistic training lands, now and in the future, for Army readiness training and installation sustainment.

ENVIRONMENTAL COMPLIANCE

LSMP projects/repairs support the historic 1992 EIS for the base realignment of 5ID from Ft Polk to Ft Hood. DPW, Environmental, assessed ITAM/conservation repair work to mitigate training land damage under the base realignment EIS in 1995. The main legal requirements pertinent are associated with natural and cultural resources, conservation, wildlife, and endangered species laws and regulations. LSMP complies with peacetime Army requirements, such as the Sikes Act, good land stewardship, conservation practices, and facilitates work coordination with DPW, Environmental, Natural and Cultural Resources.

RELATIONSHIP TO CONSERVATION

LSMP has a positive impact on conservation of land resources on Fort Hood. Projects have conservation and environmental applications and enhance readiness training. Projects could be funded by individual agencies or shared in a combination to properly meet funding requirements. Conservation practices, Master Planning upgrades and Real Property maintenance are integrated into the projects list, as issues required for sustain training land infrastructure and facilities, upgrades and construction of new facilities and ranges to provide for a viable and holistic installation training land management system.

PRIORITIZED WORK

Work responsibilities are divided between 4 primary installation agencies:

1) DPTS, Range Control (RC)
   a) Range maintenance program
   b) Range upgrades and range master plans –MCA-
   c) Range and Training Land Program (RTLP)

2) Range Control, Integrated Training Area Management (ITAM) Program
   a) Land Conditions Trend Analysis (LCTA)

b) Land Rehabilitation and Maintenance (LRAM)
c) Geographic Information System (GIS)
d) Training Requirements Integration (TRI)
e) Sustainable Range Awareness (SRA)

3) DPW, Environmental Division
a) Natural Resource Management
b) Conservation Management
c) Erosion Management
d) Endangered Species Management
e) Wildlife Management
f) Pest Management
g) Cultural Resource Management
h) Environmental Management
i) HAZMAT Management
j) NEPA
k) Air Management
l) Water Management

4) DPW maintenance, repair and upgrade programs
a) Master Planning
b) Real Property

The following primary training land issues are concerns to sustaining training and long-term land resource sustainment:

1) Tank trail network, trafficability and erosion reduction
2) Protection and sustainment of Endangered Species while reducing training limitations
3) Protection and mitigation of eligible cultural sites while reducing training limitations
4) Hardening of stream crossings, trafficability and erosion reduction
5) Hardening of hilltop access trails, trafficability and erosion reduction
6) Erosion control structure construction and maintenance
7) Hardening of high use staging/assembly areas
8) Critical land, unserviceable areas, and gully treatments to reduce erosion and improve maneuver
9) Vegetation re-establishment and maintenance

10) Brush management (juniper and mesquite)
11) Hardening of command/logistic (BSA) areas-Tactical Concealment Areas
13) Mulching brush piles to open terrain to enhance maneuver and compaction to narrow lanes of access
14) Firebreak network maintenance
15) LCTA monitoring of training land health
16) Sustainable Range and Environmental Awareness education/training and maps
17) Installation Maneuver Damage Program, education, and leadership emphasis
18) Regional prescribed burning
19) Repair/construction of damaged or unserviceable infrastructure facilities
20) Grazing lease management
21) Noise education for the public
22) Oak wilt management

TRAINING LAND CONDITIONS

ITAM LCTA conducted several training land health and soil erosion studies on the West side of the installation. The Installation Status Report for FY01 thru 03, evaluated land conditions at C3. Insufficient funds, increased training requirements, backlogged land repairs, erosion, bare ground (lack of vegetation), and new land damaged during training continue to degrade training land capabilities and conditions.

Actions are needed to improve the installation land conditions before they degrade to C4 and severely impact training capabilities to conduct realistic training and vastly increase land rehabilitation costs on the landscape.

BENEFITS

LSMP can reverse current land conditions and achieve the sustainment of Fort Hood Training Land resources. Proactive, integrated management of land resources, will reduce redundancy of work and costs between installation agencies, and promote a cooperative work effort on the following land sustainment goals:

- Repair and sustainment of training land to provide adequate and realistic training, now and to future trainers
- Improve quality of training through land management and repairs
- Establish and sustain training land vegetation
- Sustain the installation ecosystem
- Improve downstream water quality and quantity and reduce sediment leaving the installation
- Improve trainer access to training lanes
- Reduce erosion rates on the installation
- Sustain the endangered species and cultural resources on the installation
- Reduce critical/unserviceable areas in training lanes
- Reduce 50 years of backlogged land repairs using the Training Out Area Program
- Enhance TADSS use on the installation
- Prioritize and manage installation land repairs and improve installation training land conditions
- Integrate land stewardship practices into military planning and responsibilities
- Provide a forum for trainers and environmentalists to discuss concerns and annual plans

COSTS

The estimated cost to implement the LSMP, from FY04 through FY09, is $588 M ($79M-ITAM, $165M-NR, $26M-CR, $270M-RC and $48M-RP/Master Plan). Many of the current LSMP projects have training and conservation objectives, issues and goals and projects could be obligated by DPTS or DPW. Installation RP must fund infrastructure maintenance projects and play an increasing active role to sustain the training land infrastructure.

IMPLEMENTATION

Implementation of LSMP will improve our land conditions and provide for the sustainment of readiness training within limited training land resources. The following actions must occur to properly implement the plan.

- Command emphasis and support

- Adequate funding and dedicated resources for land managers to execute this plan in conjunction with the Training Out Area Program

- Sustainable Range and Environmental Awareness education of military units and commanders

- Implement a Maneuver Damage Program

- To provide realistic landscapes to support training

FUNDING LEVELS

The following does not include range funding. The FY03 training land funding trend was 45% of required. FY04 funding was 20% of required. FY05 training land funding is projected at less than 8%. If funding levels continue, it will take 25 years to repair current land damages to Fort Hood Training Land Resources.

Chapter 1
Installation Land Sustainment Management Plan (LSMP)
Agencies

1. The missions of the Installation Land Sustainment Plan are to identify land repair requirements, hold installation agencies responsible for land repair and maintenance, and ensure the agencies plan, work, repair, and sustain the training landscape as a cohesive team. It remains each agency's responsibility to plan, request, and capture resources to sustain our training lands.

2. The primary installation agencies responsible for sustaining Fort Hood Training Lands are:
   - Installation Garrison Commander
   - Directorate for Public Works (DPW)
   - DPW, Environmental, Natural Resources (NR)
     - NR, Conservation
     - NR, Endangered Species
     - NR, Wildlife Management
     - NR, Pest Management
   - DPW, Cultural Resources
   - DPW, Master Planning
   - DPW, Real Property-Infrastructure
   - Directorate for Planning, Training & Security (DPTS)
   - DPTS, Range Control (RC)
     - RC, Live Fire Training
     - RC, Range Master Planning
     - RC, Integrated Training Area Management (ITAM)

3. Supporting agencies:
   - USDA, Natural Resource Conservation Services (NRCS)
   - TAMUS, Blacklands Research Center

4. Training land sustainment responsibilities are divided into two primary missions; live fire training areas and maneuver training areas sustainment.
   a. DPTS, RC uses training and OPA dollars to sustain and modernize the live fire training areas.
   b. DPW uses OMA and other conservation dollars to sustain the maneuver training areas.
   c. ITAM uses training dollars to sustain live fire and maneuver training areas.

5. DPTS and DPW responsibilities overlap across the installation land sustainment management plan as projects

and issues overlap the live fire and maneuver training areas and both agencies must balance mission/use requirements and land resources in order to maintain existing resources for current and future mission/use requirements.

6. An integrated installation land sustainment management plan is the ideal method of sustaining land resources and allow for the repair and maintenance of our land resources, while sustaining training and ancillary land use requirements.

7. Land sustainment is a myriad of complex issues, which continue to evolve as use requirements mature or change and as new requirements are identified. It is the responsibility of the LSMP agencies to remain flexible and adapt to changing requirements to indefinitely protect and sustain our land resources to meet all land use requirements by ensuring land repair timeframes, prioritization of land, funding, continuous planning, and execution of the LSMP are balanced with mission requirements to sustainment the installation’s readiness and land resources.

8. Supporting agencies provide expertise for land monitoring, area conditions, trends, health, land repair, conservation and sustainment practices and compliance to ensure land repair efforts promote land sustainment and land repair efforts.

9. All land activities must be integrated, managed, and controlled to ensure adequate land resources are available for future generations.

Chapter 2
Land Sustainment Goals

The Training Land Committee 25-year sustainment goal:

Training landscapes managed to support current and future mission requirements while sustaining cultural, natural and land resources

Sub-goals, initiatives and issues

1. Develop and implement an installation land sustainment management plan (LSMP) to sustain the Fort Hood Training landscapes, balancing all land use with the natural resources within their capability to be sustained at an acceptable healthy level (Short range (FY04-09); Mid range (FY10-14); Long range (FY15-27)
   a. Integrate all training land activities/plans
      1) Incorporate cultural, ES, tank trail and maintenance, natural resource plan, conservation plan, grazing, prescribed burning, range plan, erosion plans, land monitoring, land repairs, DPW and ITAM plans
      2) Develop an integrated land management repair plan to sustain the training landscape
      3) Improve training land conditions and ecosystem
      4) Improve soil erosion management
      5) Improve vegetation, reduce bare ground, and manage grazing to allow for prescribed burning and primary land use missions
      6) Improve training access to training lanes
      7) Reduce critical area treatment sites, unserviceable areas, in training lanes
      8) Improve TADSS use thru juniper management and prescribed burning
      9) Improve/harden high use areas to support training and reduce erosion
      10) Reduce land repair backlog under the Training Out Area Program
      11) Develop and implement a scrap metal and target residue management plan
      12) Develop a water and ground contaminant management plan

13) Perform ongoing training landscape needs assessment/monitoring
14) Integrate and balance training requirements and other land use requirements

b. Develop and maintain an integrated land database
   1) Establish Training land baselines
      a) An installation land mass and training area boundaries layer
      b) An installation road and trails layer
      c) Pick up all primary roads and trails, stream crossings, hilltop crossings, erosion dams, and staging areas on the books
      d) An installation GIS layer and terminology for all infrastructures
      e) An installation stream and hilltop crossings and staging areas layer
   2) An installation repair list with detailed information for planning, funding, and repairs

c. Sustain and de-list endangered species (ES)
   1) ES habitat management
   2) Reduce Core habitat training limitations
   3) Develop new ES habitat outside the installation boundary, lessen habitats on post
   4) Improve the Firebreak Network to protect ES habitats without impacting live fire training
   5) Develop an outreach program to other regions to allow them to meet their regional bird goals and expand their populations to de-list these species from the Endangered Species Act.

d. Protect cultural sites
   1) Identify all eligible sites
   2) Protect eligible sites in maneuver lanes
   3) Protect eligible sites at risk of damage or destruction on the installation

e. Prioritize land activities according to mission requirements

f. Improve training land conditions
   1) Reduce training land erosion rates
   2) Improve water quality with BMPs
   3) Repair and maintain tank trail networks
   4) Reduce training constraints

5) Improve biodiversity
6) Reduce vegetation constraints to training

2. Develop and implement an education and awareness program
   a. Educate military and leadership on land stewardship
   b. Implement Sustainable Range Awareness education
   c. Educate leadership on environmental awareness
   d. Implement awareness education for company and field grade officers in command positions
   e. Partnering with community to address urban sprawl issues
   f. Implement soldier in-processing awareness education
   g. Integrate ITAM and environmental training standards and practices into education
   h. Expand land stewardship training taught at West Point, basic training, AIT and NCO and Officer advance courses
3. Develop and implement an accountability and reporting system
   a. Command emphasis and support of the land sustainment management plan
   b. Implement and enforce an installation maneuver damage program
   c. Land managers conduct joint inventories on land
   d. Land managers responsible for clearing subordinate and joint-use units
   e. Develop command inspection checklists to address land resource considerations
   f. Provide a forum for trainers and environmentalists to discuss concerns and annual land and training plans
   g. Break the 'you can do anything you want during training at Fort Hood' mind set
4. Balance training requirements and land resources
   a. Balance virtual and live training to reduce training costs and encroachment issues
   b. Improve quality of training through land management and repairs
5. Future Forces issues/support
   a. Evaluate range requirements
   b. Evaluate training land requirements
   c. Evaluate training support requirements
   d. Evaluate training densities impacts on erosion rates on the installation

e. Evaluate training densities impacts on sediment leaving the installation
f. Develop a mesquite management plan to support future forces maneuver training across the landscape.
g. Improve the trail network to support future forces training
h. Increase mid and high level crossing to support future forces training

6. Integrate all training land users/plans
   a. Maintain the land balance between endangered species and training requirements
   b. Update GSI data layers annually to support the Land Sustainment Management Plan
   c. Update and implement training land digging permit procedures
   d. Develop and implement an installation training land management (ITLM) (user) group to integrate all land use/requirements
      1) Identify membership and authority
      2) Identify relevant plans and programs
      3) Consolidate training land management processes
      4) Establish a formal review process
      5) Establish a land decisions process for GO/GC land recommendations
   e. Update the Training Out Area Program to support training and land repair/conservation requirements

7. Protect existing sediment retention measures to sustain training
   a. Monitor and forecast sediment structure capacity and life
   b. Remove sediment from retention structures to extend structure life
   c. Remove sediment from Cowhouse Creek Arm in TA8

Chapter 3
FUNDING

1. The revised Short Range Funding Requirements to fund the FY04-09 plan is $588 M. If you remove the live fire requirements, then $318 M is needed for training land sustainment.

   a. $270 M is required to repair and maintain live fire training costs and range modernization.
   b. $247.5 M is required to repair known land damages and trails to sustain the maneuver training landscape.
   c. $70.6 M is required to sustain endangered species, cultural, pest, and wildlife programs.

2. Here are the installation agencies requirements for training land sustainment.

	SHORT RANGE SUSTAINMENT FUNDING REQUIREMENTS (in $ Millions)						
OPERATIONAL COSTS	FY04	FY05	FY06	FY07	FY08	FY09	FY04-09 TOTALS:
Training Land Sustainment Estimates:	88.23	129.55	95.79	95.88	114.05	64.6	588.1
DPW,	53.55	49.2	50.13	43.13	20.45	23.17	239.63
Conservation Program	26.4	25.48	25.48	25.48	7.72	10.3	120.86
Endangered Species Program	7.4	6.8	6.8	6.8	6.5	6.5	40.8
Wildlife Program	0.79	0.54	0.54	0.6	0.6	0.6	3.67
Pest Management	0.04	0.04	0.04	0.04	0.04	0.04	0.24
Real Property- Maintenance	0.74	0.88	1.11	1.23	1.37	1.53	6.86
Master Planning- Primary Tank Trails	14	11	11.5	4.8	0	0	41.3
Cultural Resources	4.18	4.46	4.66	4.18	4.22	4.2	25.9
DPTM, Range Control (RC)	34.68	80.35	45.66	52.75	93.6	41.43	348.47
RC, Live Fire Training Program	21	22	22	22	22	22	131
RC, Range Master Planning MCA/OPA	0	45	12	19	56	7	139
RC, ITAM Program	13.68	13.35	11.66	11.75	15.6	12.43	78.47

3. Training land funding for FY04 was less than 20%. FY05 training land funding is projected at less than 9%.

4. For values of Ranges, Endangered Species, Pest Management, and Wildlife, see appropriate tabs.

5. Here is what the Short Range Management Plan (ITAM, Conservation, Cultural, Real Property, and Master Planning) funding will buy.

a. Infrastructure:

1) 9 Miles of Double Lane Primary Trails
2) 171 Miles of Single Lane Primary Trails
3) 220 Miles of Secondary Trails
4) 20 Erosion (sediment retention) Structures
5) 88 Hilltop Access Trails
6) 169 Stream Crossings (low water)
7) 2 Stream Crossings (mid level water)
8) 1 Stream Crossing (high water)
9) 24 Staging Areas (high use)
10) 5 Tactical Concealment Areas
11) 69 Rock Check Dams (large)
12) 5 Miles of Firebreak Trails
13) 900 Acres of Mulching
14) 33 Pipeline Crossings
15) 4 River Crossing/Bridge Abutments

b. Management/sustainment:

1) 10,000 acres of Prescribed Burning
2) 20,160 acres of Repairing Severely Damaged Land
3) 37,500 acres of Repairing Moderately Damaged Land
4) Numerous Spot Repairs under Land Stabilization and Materials
5) Annual Maintenance and Repair of 130 miles of Firebreak Network
6) 23,100 Acres of Vegetation Management
7) 5,700 Acres of Mesquite Management
8) 20,500 Acres of Juniper Management
9) 100 area plots Monitored, annually under LCTA
10) 1 Post-wide Photo flights to identify and monitor changes in the landscape and land conditions

c. Infrastructure Maintenance Costs (New & Old)

16) 113 Miles of Paved Roads & Shoulders
17) 82 Miles of All Weather Roads & Shoulders
18) 400 Miles of Primary & Secondary Trails
19) 195 Stream Crossings
20) 90 Hilltop Access Trails
21) 56 Erosion (sediment retention) Structures
22) 33 Staging Areas
23) New items from above

d. Cultural Sites

1) 785 Sites Study and Assess Sites
2) 100 Sites Protection (cap & barricade) Sites in Maneuver Lanes…12 funded by ITAM
3) 6 Sites Excavation and Recover Data Out

e. Sustainable Range Awareness Education

1) 60,000 Fort Hood Training Maps, with Environmentally sensitive areas identified, distributed to units annually
2) Production of SRA DVDs for educational use by DPW, units, leaders, and soldiers
3) SRA products to provide a training POC for unit/soldier questions about training and good training land stewardship practices

Chapter 4
Training Out Area Program

1. The majority of land repair and sustainment work is programmed to occur under the Training Out Area Program. The Out Area Program becomes the driving force for repair funding requirements and divides the Western Training Lands into 6 sections to balance training requirements and land repairs to sustain the installation.

2. Each Out Area becomes the primary land repair area for the installation. Training is deferred during the year an area is out to restore vegetation/ground cover. Cattle grazing is deferred until the latest forage assessments indicate adequate forage availability and the area is not scheduled for the out area land repairs/vegetation recovery. With six out areas, each area is normally visited for repairs every six years. Priority land repair work can be required outside of the out area program.

3. Funding drives the extent of and volume of land repairs done to each Out Area. This is where integrating repair work by the DPW and DPTS combines work efforts to maximize funding and land resource repairs. Projects are combined or one entity can fund one of the various repair practices. Teamwork and coordination of work reduces redundant work efforts and paperwork while making the most of the resources available to sustain our training lands.

4. The Out Area Program intent is to repair lands to improve readiness training, reduce erosion, promote vegetation growth, enhance training access and shape unserviceable areas into useable areas that can sustain the training landscape. The program results are successful but results are limited to resources provided to the program.

Chapter 5

The Short Range Land Sustainment Management Plan

1. The plan uses the Garrison Commander's five sub-goals as baselines in identifying associated training land issues and objectives to make a detailed and workable installation Land Sustainment Management Plan. This section will outline the expanded and related goals and what the responsible agencies are planning.

2. Each agency maintained responsibilities for their proponent but collaborated in the process for the sustainment of the installation landscape. This concept will continue throughout the 25 year sustainment plan. A detailed plan is focused towards a short range plan while keeping options open towards resolving complex land sustainment issues the mid and long range timeframes.

3. The primary mission of the installation Land Sustainment Management Plan is repairing the land to provide adequate land resources for the future. The mission objectives of the plan are to repair land damage before erosion damage increases, implement a land management system to ensure land resources meet training requirements and land sustainment objectives, protection of eligible cultural sites until they can be mitigated, protection of our sustainable endangered species until they can be de-listed, and implement an education system that will neutralize some encroachment concerns and minimize ecosystem damage and land contamination. Chapter 2 addresses the Endangered Species and Cultural Resource goals for the plan.

4. The plan identifies numerous land practices to rehabilitate and sustain the landscape resources. The main practices are:

   a. Erosion Control, Landscape Sustainment
      1) Critical Area Treatment
      2) Tank Trail networks
      3) Stream Crossings
      4) Hilltop Access Trails
      5) Erosion Control Dams
      6) Staging Area Treatment
      7) Training Damage Repair
      8) Land Stabilization and Materials - Maintenance
      9) Prescribed Burning

b. Cultural Sites Sustainment
c. Endangered Species Sustainment
d. Infrastructure maintenance

5. These practices enhance our land capabilities to train and maneuver, while reducing erosion and preserving endangered species and cultural resources.

6. The short range LSMP mission is to repair and enhance land resources. Sustainment cannot be maintained without viable land resources to support mission requirements or agencies resources and command support.

7. Each agency is responsible for their FY04-09 work plan and to capture adequate resources to implement their portion of the plan. The primary land agencies work plans and management areas for training land sustainment are at Tabs.

Chapter 6
Mid and Long Range LSMP

1. The mid (FY10-14) and long (FY15-27) range LSMP continues to sustain training requirements and the installation landscape FY10-27. This is a suspensed window for implementing several missions.

2. Endangered Species Outreach program is implemented. State and federal funding is leveraged. The other ES regions in Texas and Oklahoma use the Hood program, which met the target populations in 2000. By 2014, these regions should meet their target populations. The 2 bird Endangered Species can only be de-listed if 3 of 4 and 4 of 5 regions meet their population goals. By 2025, we request for ES de-listing and remove the majority of training limitations imposed during nesting 6 months each year.

3. Cultural sites mitigation is the next objective now that sites inside the training lanes are protected. Demonstrations of data recovery are conducted outside training lanes and costs estimates are refined. Mitigation continues to maximize site recovery and removal from the eligible inventory. State and federal funding is leveraged. Sites in maneuver lanes are evaluated and only worked when land is in the Training Out Area Program. Sites in the live fire area are work inside the range modernization program.

4. Public outreach programs are implemented to educate concerned citizens. The public sees noise as a patriotic cost for living around Hood. Studies are made public to show no munitions are migrating from Hood. Hood removes sediment the mouth of Belton Lake to restore reservoir capacity and removes sediment from erosion dams to prolong their lifespan to support water quality and quantity for drinking water. Hood investigates the procurement of additional lands to support FORCE XXI requirements, move ES habitats from maneuver and live fire training lands, and to lessen the effects of noise and dust concerns on the public.

5. Training land infrastructure is maintained through Real Property and upgrades worked through Master Planning.

Conservation and ITAM resources are used to repair new maneuver land damage, minimize erosion, and reduce the repairs backlog.

6. Green bullets are used in live fire training and training units use simulators 50% of the yearly OPTEMPO and unit training requires land half of a year.

7. Scrap metal and target residues are contracted, shipped and smelted without lengthy paperwork and can be moved from ranges to trains without numerous inspections and certifications. Hood uses the recycle funds to improve the live fire range infrastructure.

8. Trail networks are maintained to support future forces combat vehicles.

9. Military Land Stewardship and awareness education are part of the peacetime Army at Hood. ODP and NCODP classes promote awareness. DPW integrates sustainable range awareness into environmental courses and classes. Environmental, Awareness, and land stewardship education courses available for soldiers, leaders, units, and senior commanders. Command emphasis, command inspections, and the maneuver damage program are working. Leaders are teaching the new soldiers. Units are receiving “Green” awards.

10. Contaminated water and soils are collected, processed and recycled back into the landscape.

TAB A: ITAM Plan

FY04 Summary			
CODE	**UNIT**	**QUANTITY**	**EST. COST (K)**
CAP, cap/protect cult site from maneuvers	ea	2	20
CAT, critical area & gully treatment	ac	3201	3,873
CBT, combat trail network	mi	9	630
ECS, erosion sediment control dam	ea	1	580
FBM, Firebreak Maintenance	mi	50	60
FBT, fire break trail	mi	2	140
HAT, hilltop access trail	ea	9	1,380
LSM, land stabilization and materials	ac	na	555
PLC, pipe line crossing	ea	6	32
RCD, rock check dam	ea	7	115
SAT, staging area treatment	ea	4	800
TCA, tactical concealment area	ea	1	200
TDR, training damage repair	ac	4404	2,423
VEG, vegetation/seeding	ac	2000	150
XNG, stream crossing	ea	33	2,486
FHTM, Fort Hood Training Maps	ea	30000	50
LCTA, Land Conditions Trend Analysis	ea	120	100
ORTHO, Post Ortho-photography (TC)	ea	1	75
SRAM, Sustainable Range Awareness Materials	ea	10	5
SRAV, Sustainable Range Awareness Videos	ea	1	10
		TOTAL	13,684

FY05 Summary			
CODE	**UNIT**	**QUANTITY**	**EST. COST (K)**
CAP, cap/protect cult site from maneuvers	ea	2	20
CAT, critical area & gully treatment	ac	3340	3,041
CBT, combat trail network	mi	2	140
ECS, erosion sediment control dam	ea	1	200
FBM, Firebreak Maintenance	mi	50	75
FBT, fire break trail	mi	2.5	175
HAT, hilltop access trail	ea	9	1,260
LSM, land stabilization and materials	ac	na	555
RCD, rock check dam	ea	29	800
SAT, staging area treatment	ac	14	1,400
TCA, tactical concealment area	ea	1	200
TDR, training damage repair	ac	9,835	3,826
VEG, vegetation/seeding	ac	2000	150
XNG, stream crossing	ea	10	1,340
FHTM, Fort Hood Training Maps	ea	30	50
LCTA, Land Conditions Trend Analysis	ea	120	100
SRAM, Sustainable Range Awareness Materials	ea	10	5
SRAV, Sustainable Range Awareness Videos	ea	1	10
		TOTAL	13,347

FY06 Summary			
CODE	**UNIT**	**QUANTITY**	**EST. COST (K)**
CAP, cap/protect cult site from maneuvers	ea	2	20
CAT, critical area & gully treatment	ac	1,843	1,231
CBT, combat trail network	mi	10	700
ECS, erosion sediment control dam	ea	1	150
FBM, Firebreak Maintenance	mi	50	60
HAT, hilltop access trail	ea	28	3,335
LSM, land stabilization and materials	ac	na	555
PLC, pipe line crossing	ea	17	154
RCA, River Crossing Abutment	ea	2	200
SAT, staging area treatment	ea	6	1,200
TCA, tactical concealment area	ea	2	400
TDR, training damage repair	ac	2,511	1,136
VEG, vegetation/seeding	ac	2,000	150
XNG, stream crossing	ea	25	2,205
FHTM, Fort Hood Training Maps	ea	30,000	50
LCTA, Land Conditions Trend Analysis	ea	120	100
SRAM, Sustainable Range Awareness Materials	ea	10	5
SRAV, Sustainable Range Awareness Videos	ea	1	10
		TOTAL	11,661

FY07 Summary			
CODE	**UNIT**	**QUANTITY**	**EST. COST (K)**
CAP, cap/protect cult site from maneuvers	ea	2	20
CAT, critical area & gully treatment	ac	4,093	4,954
CBT, combat trail network	mi	6	420
FBM, Firebreak Maintenance	mi	50	60
HAT, hilltop access trail	ea	11	1,750
LSM, land stabilization and materials	ac	na	555
PLC, pipe line crossing	ea	9	45
RCA, River Crossing Abutment	ea	2	200
SAT, staging area treatment	ea	5	1,000
TCA, tactical concealment area	ea	1	200
TDR, training damage repair	ac	1,640	827
VEG, vegetation/seeding	ac	2,000	150
XNG, stream crossing	ea	14	1,400
FHTM, Fort Hood Training Maps	ea	30,000	50
LCTA, Land Conditions Trend Analysis	ea	120	100
SRAM, Sustainable Range Awareness Materials	ea	10	5
SRAV, Sustainable Range Awareness Videos	ea	1	10
		TOTAL	11,746
FY08 Summary			
CODE	**UNIT**	**QUANTITY**	**EST. COST (K)**
CAP, cap/protect cult site from maneuvers	ea	2	20
FBM, Firebreak Maintenance	mi	50	60
HAT, hilltop access trail	ea	18	2,290
LSM, land stabilization and materials	ac	na	555
MLC, Mulching	ac	600	50
SAT, staging area treatment	ea	1	200
TDR, training damage repair	ac	14,058	8,387
VEG, vegetation/seeding	ac	2,000	150
XNG, stream crossing	ea	38	3,655
FHTM, Fort Hood Training Maps	ea	30	50
LCTA, Land Conditions Trend Analysis	ea	120	100
ORTHO, Post Ortho-photography (TC)	ea	1	75
SRAM, Sustainable Range Awareness Materials	ea	10	5
SRAV, Sustainable Range Awareness Videos	ea	1	10
		TOTAL	15,607
FY09 Summary			
CODE	**UNIT**	**QUANTITY**	**EST. COST (K)**
CAP, cap/protect cult site from maneuvers	ea	2	20
CAT, critical area & gully treatment	ac	1,000	168
CBT, combat trail network	mi	6	420
FBM, Firebreak Maintenance	mi	50	60
HAT, hilltop access trail	ea	12	2,105
LSM, land stabilization and materials	ac	na	555
PLC, pipe line crossing	ea	1	5
RCD, rock check dam	ea	12	305
SAT, staging area treatment	ea	1	200
TDR, training damage repair	ac	5,100	2,640
VEG, vegetation/seeding	ac	2,000	150
XNG, stream crossing	ea	48	5,636
FHTM, Fort Hood Training Maps	ea	30,000	50
LCTA, Land Conditions Trend Analysis	ea	120	100
SRAM, Sustainable Range Awareness Materials	ea	10	5
SRAV, Sustainable Range Awareness Videos	ea	1	10
		TOTAL	12,429

FY04 Summary				
CODE	**UNIT**	**QUANTITY**	**EST. COST (K)**	
BURN, Prescribed Burning	AC	12000	120	
CAT, critical area & gully treatment	AC	4558	5,926	
CBT, combat trail network	MI	114	20,000	
Endangered Species Management	RP	12	7,400	
FBM, Firebreak Maintenance	MI	100	140	
JNM, Juniper Management	AC	1,000	500	
MLC, Mulching	AC	500	200	
MSM, Mesquite Management	AC	100	30	
VEG, vegetation/seeding	AC	1000	120	
ORTHO, Post Ortho-photography (IR)	EA	1	75	
Wildlife Management	Surveys	2	79	
Pest Management	Programs	2	40	
		TOTAL	34,630	
FY05 Summary				
CODE	**UNIT**	**QUANTITY**	**EST. COST (K)**	
BURN, Prescribed Burning	AC	12000	120	
CAT, critical area & gully treatment	AC	3735	4,856	
CBT, combat trail network	MI	114	20,000	
Endangered Species Management	RP	12	6,800	
FBM, Firebreak Maintenance	MI	100	140	
JNM, Juniper Management	AC	1,000	500	
MLC, Mulching	AC	500	200	
MSM, Mesquite Management	AC	100	30	
VEG, vegetation/seeding	AC	1000	120	
Wildlife Management	Surveys	2	54	
Pest Management	Programs	2	40	
		TOTAL	32,860	
FY06 Summary				
BURN, Prescribed Burning	AC	12000	120	
CAT, critical area & gully treatment	AC	3735	4,856	
CBT, combat trail network	MI	114	20,000	
Endangered Species Management	RP	12	6,800	
FBM, Firebreak Maintenance	MI	100	140	
JNM, Juniper Management	AC	1,000	500	
MLC, Mulching	AC	500	200	
MSM, Mesquite Management	AC	100	30	
VEG, vegetation/seeding	AC	1000	120	
Wildlife Management	Surveys	2	54	
Pest Management	Programs	2	40	
		TOTAL	32,860	

FY07 Summary				
CODE	**UNIT**	**QUANTITY**	**EST. COST (K)**	
BURN, Prescribed Burning	AC	12000	120	
CAT, critical area & gully treatment	AC	3735	4,856	
CBT, combat trail network	MI	114	20,000	
Endangered Species Management	RP	12	6,800	
FBM, Firebreak Maintenance	MI	100	140	
JNM, Juniper Management	AC	1,000	500	
MLC, Mulching	AC	500	200	
MSM, Mesquite Management	AC	100	30	
VEG, vegetation/seeding	AC	1000	120	
Wildlife Management	Surveys	2	54	
Pest Management	Programs	2	40	
		TOTAL	32,860	
FY08 Summary				
CODE	**UNIT**	**QUANTITY**	**EST. COST (K)**	
BURN, Prescribed Burning	AC	12000	120	
CAT, critical area & gully treatment	AC	5497	7,150	
CBT, combat trail network	MI	0	0	
Endangered Species Management	RP	12	6,500	
FBM, Firebreak Maintenance	MI	100	140	
JNM, Juniper Management	AC	1,000	500	
MLC, Mulching	AC	500	200	
MSM, Mesquite Management	AC	100	30	
VEG, vegetation/seeding	AC	1000	120	
Wildlife Management	Surveys	2	60	
Pest Management	Programs	2	40	
		TOTAL	14,860	
FY09 Summary				
CODE	**UNIT**	**QUANTITY**	**EST. COST (K)**	
BURN, Prescribed Burning	AC	12000	120	
CAT, critical area & gully treatment	AC	5497	7,150	
CBT, combat trail network	MI	14	2,580	
Endangered Species Management	RP	12	6,500	
FBM, Firebreak Maintenance	MI	100	140	
JNM, Juniper Management	AC	1,000	500	
MLC, Mulching	AC	500	200	
MSM, Mesquite Management	AC	100	30	
VEG, vegetation/seeding	AC	1000	120	
Wildlife Management	Surveys	2	60	
Pest Management	Programs	2	40	
		TOTAL	17,440	

TAB C: Cultural Plan

FY04 SUMMARY			
CODE	**UNIT**	**QUANTITY**	**EST.COST (K)**
Cap Hist-Elig sites in Training Lanes	ea	18	260
Site Excavation / non outarea, maneuver, livefire	ea	1	3,000
Site Study Assessments	ea	na	920
		TOTAL	4,180
FY05 SUMMARY			
CODE	**UNIT**	**QUANTITY**	**EST.COST (K)**
Cap Hist-Elig sites in Training Lanes	ea	27	540
Site Excavation / non outarea, maneuver, livefire	ea	1	3,000
Site Study Assessments	ea	na	920
		TOTAL	4,460
FY06 SUMMARY			
CODE	**UNIT**	**QUANTITY**	**EST.COST (K)**
Cap Hist-Elig sites in Training Lanes	ea	37	740
Site Excavation / non outarea, maneuver, livefire	ea	1	3,000
Site Study Assessments	ea	na	920
		TOTAL	4,660
FY07 SUMMARY			
CODE	**UNIT**	**QUANTITY**	**EST.COST (K)**
Cap Hist-Elig sites in Training Lanes	ea	13	260
Site Excavation / non outarea, maneuver, livefire	ea	1	3,000
Site Study Assessments	ea	na	920
		TOTAL	4,180
FY08 SUMMARY			
CODE	**UNIT**	**QUANTITY**	**EST.COST (K)**
Cap Hist-Elig sites in Training Lanes	ea	15	300
Site Excavation / non outarea, maneuver, livefire	ea	1	3,000
Site Study Assessments	ea	na	920
		TOTAL	4,220
FY09 SUMMARY			
CODE	**UNIT**	**QUANTITY**	**EST.COST (K)**
Cap Hist-Elig sites in Training Lanes	ea	14	280
Site Excavation / non outarea, maneuver, livefire	ea	1	3,000
Site Study Assessments	ea	na	920
		TOTAL	4,200

TAB D: Master Planning

FY04 SUMMARY			
CODE	**UNIT**	**QUANTITY**	**EST.COST (K)**
Primary Double Lane Trail Construction	MI	9	3,150
Primary Single Lane Trail Construction	MI	49	9,800
Mid Water Crossing	EA	1	800
		TOTAL	13,750
FY05 SUMMARY			
CODE	**UNIT**	**QUANTITY**	**EST.COST (K)**
Primary Single Lane Trail Construction	MI	51	10,200
Mid Water Crossing	EA	1	800
		TOTAL	11,000
FY06 SUMMARY			
CODE	**UNIT**	**QUANTITY**	**EST.COST (K)**
Primary Single Lane Trail Construction	MI	47	9,400
High Water Crossing	EA	1	2,000
		TOTAL	11,400
FY07 SUMMARY			
CODE	**UNIT**	**QUANTITY**	**EST.COST (K)**
Primary Single Lane Trail Construction	MI	24	4,800
		TOTAL	4,800
FY08 SUMMARY			
CODE	**UNIT**	**QUANTITY**	**EST.COST (K)**
FY09 SUMMARY			
CODE	**UNIT**	**QUANTITY**	**EST.COST (K)**

FY04 SUMMARY			
CODE	**UNIT**	**QUANTITY**	**EST.COST (K)**
Paved Road Maintenance	mi	113	136
All Weather/Loose Surface Road Maintenance	mi	82	82
Trail Maintenance	mi	95	71
Stream Crossing Maintenance	ea	60	120
Hilltop Access Trail Maintenance	ea	15	30
Erosion Structure Maintenance	ea	46	230
Staging Area Maintenance	ea	13	65
		TOTAL	734
FY05 SUMMARY			
CODE	**UNIT**	**QUANTITY**	**EST.COST (K)**
Paved Road Maintenance	mi	113	136
All Weather/Loose Surface Road Maintenance	mi	82	82
Trail Maintenance	mi	175	131
Stream Crossing Maintenance	ea	70	140
Hilltop Access Trail Maintenance	ea	21	42
Erosion Structure Maintenance	ea	50	250
Staging Area Maintenance	ea	20	100
		TOTAL	881
FY06 SUMMARY			
CODE	**UNIT**	**QUANTITY**	**EST.COST (K)**
Paved Road Maintenance	mi	113	136
All Weather/Loose Surface Road Maintenance	mi	82	82
Trail Maintenance	mi	282	212
Stream Crossing Maintenance	ea	95	190
Hilltop Access Trail Maintenance	ea	49	98
Erosion Structure Maintenance	ea	52	260
Staging Area Maintenance	ea	26	130
		TOTAL	1,108
FY07 SUMMARY			
CODE	**UNIT**	**QUANTITY**	**EST.COST (K)**
Paved Road Maintenance	mi	113	136
All Weather/Loose Surface Road Maintenance	mi	82	82
Trail Maintenance	mi	320	240
Stream Crossing Maintenance	ea	109	218
Hilltop Access Trail Maintenance	ea	60	120
Erosion Structure Maintenance	ea	56	280
Staging Area Maintenance	ea	31	155
		TOTAL	1,231

FY08 SUMMARY			
CODE	**UNIT**	**QUANTITY**	**EST.COST (K)**
Paved Road Maintenance	mi	113	136
All Weather/Loose Surface Road Maintenance	mi	82	82
Trail Maintenance	mi	349	262
Stream Crossing Maintenance	ea	147	294
Hilltop Access Trail Maintenance	ea	78	156
Erosion Structure Maintenance	ea	56	280
Staging Area Maintenance	ea	32	160
		TOTAL	1,370
FY09 SUMMARY			
CODE	**UNIT**	**QUANTITY**	**EST.COST (K)**
Paved Road Maintenance	mi	113	136
All Weather/Loose Surface Road Maintenance	mi	82	82
Trail Maintenance	mi	400	300
Stream Crossing Maintenance	ea	195	390
Hilltop Access Trail Maintenance	ea	90	180
Erosion Structure Maintenance	ea	56	280
Staging Area Maintenance	ea	33	165
		TOTAL	1,533

TAB F: ENDANGERED SPECIES MANAGEMENT PLAN FOR FORT HOOD

EXECUTIVE SUMMARY

The presence of federally listed endangered species on Fort Hood is a significant natural resource management challenge for the Army and Fort Hood. In accordance with the Endangered Species Act of 1973, as amended, the Army must assist recovery of all listed threatened and endangered (T&E) species and their habitats under the installation's management authority. Army Regulation (AR) 200-3 requires installations to prepare an Endangered Species Management Plan (ESMP) for all listed and proposed T&E species. The installation ESMP should be used as a tool to achieve conservation objectives for populations of listed and proposed species and to minimize impacts on the training mission. The U.S. Fish and Wildlife Service Biological Opinion for Fort Hood (September 1993, as amended in 2000) provides requirements and guidance for endangered species management on Fort Hood. The ESMP is written specifically for natural resource managers and leaders of training operations on Fort Hood to accomplish military training objectives while meeting conservation objectives for T&E species.

A key feature of the ESMP is the designation of Core and Non-Core Habitat areas, and the modification of training restrictions and habitat protection measures based on these designations. Core areas are primarily large contiguous blocks of quality habitat where potential mission conflicts are below average, where habitat protection measures are enhanced and active management is performed. Non-Core areas are typically smaller, non-contiguous fragments of habitat in high conflict training areas where training restrictions have been relaxed to enhance training opportunities. Monitoring of endangered species productivity is being conducted to evaluate the effects of these land use policy changes.

The Plan provides for continued ongoing monitoring of intensive study areas for assessing critical population parameters of Golden-cheeked Warblers and Black-capped Vireos. Cowbird control through an active trapping and shooting program will be continued throughout the post, and enhanced in Core areas, with an overall target of maintaining parasitism levels in Black-capped Vireo nests at 10% or below. Findings of a predation study have identified Red Imported Fire Ants (RIFA) as a significant source of nest loss, and future research will focus on identification and implementation of appropriate management actions to limit the impacts of RIFA.

Fire management policy implementation is enhanced by a greater emphasis on the training and fielding of a wildland fire team, and extensive use of prescription burning to reduce fire hazards near Core Habitat areas. Prescription fire will be integrated into grazing deferment plans to limit woody encroachment into open training land, and to optimize early successional scrubland for Black-capped vireo.

Ongoing karst (cave) research and monitoring will be furthered by the completion of survey, mapping, and biotic collections in known karst features, and the development of a formal Karst Management Plan. Endemic species of cave invertebrates, and one new species of *Plethodontid* salamander, will receive final taxonomic review, classification, and assignment of scientific names. New karst features and any additional species discovered during routine monitoring of features will be prioritized for documentation as time and funding permits.

A formal Off-site Mitigation Plan is under development. The plan will provide a mechanism for acquisition of conservation easements or other long-term deferment of development in habitat on private lands, in exchange for further lifting of training restrictions on training lands.

The objective of this ESMP is to provide a comprehensive plan for maintaining and enhancing populations and habitats of federally listed and candidate species on Fort Hood while maintaining mission readiness in a manner consistent with Army and Federal environmental regulations.

TAB G: WILDLIFE MANAGEMENT on FORT HOOD, TEXAS

Wildlife Habitat Management

The wildlife habitat management program at Fort Hood is targeted toward restoring the ecological health of the mission lands. The primary needs have been identified as:

- Reduction of the sheet, rill, and gully erosion to acceptable limits;
- Increased native food plants;
- Reduction of wildfires;
- Additional water supplies.

The measures being implemented to restore the ecological health of the mission lands will contribute directly to improved wildlife habitat. Features are incorporated in the plans for the projects to enhance the habitat for wildlife when possible. Prescribed burning, reduced and rotational grazing, fire ant control, ES habitat management, etc.

Game Management

The DPW, Natural Resources Management Branch establishes a harvest quota for white-tailed deer, which is approved by the Texas Parks and Wildlife Department. Harvest quotas for Rio Grande Turkeys are also established by the Natural Resources Management Branch. Seasons and bag limits for all game animals will conform to state and federal laws and regulations and in some cases will be more restrictive.

Deer surveys will be conducted each year beginning in late August and terminating in mid to late September. Surveys are conducted along nine mobile spotlight lines. This method is used to determine deer density. These lines are eight to fifteen miles in length. Incidental surveys are conducted throughout the installation by driving or from helicopter. The information collected from methods used in conjunction with spotlight data to determine ratios and composition of the deer herd. Medium-sized mammal surveys are conducted in conjunction with the spotlight deer surveys.

Rio Grande Turkeys are surveyed each year by winter roost and hen-poult surveys. These surveys are conducted from ground vehicles or from helicopters. The winter roost surveys allow biologists to determine density of this species. Data collected from hen-poult surveys is used to determine reproductive success and ratios.

During the deer and turkey seasons all harvested game animals must be brought to the game check station. Biological data is collected and recorded for future use by biologists. All data collected at the game check station and from the surveys is forwarded to the Texas Parks and Wildlife Department.

Game Fish Management

The following species of game fish are being managed: largemouth bass; channel catfish; bluegill; and rainbow trout. The estimated populations of important native game fish are 10,000 largemouth bass (M. salmoides) and 16,000 channel catfish (I. Punctatus). Both species are supplemental stocked due to considerable variation in study populations throughout the year. On occasion, Fort Hood also stocks 10,000 non-indigenous rainbow trout (*Oncorhynchus mykiss*) in the winter months of the year, but this exotic is fished out by spring.

Game fish on Fort Hood will be monitored on a lake by lake basis. Each lake population is evaluated for stability based on the predator/prey relationship and desirable vs. undesirable biomass of species. When the biomass of undesirable species reaches unacceptable levels the renovation of the pond may be necessary. When an unbalanced population of game fish and forage fish is observed the removal of the excess species and/or supplemental stocking of the lacking species may be required.

Harvest regulations for fish and wildlife can be found in FH Cir 210-YY-22. All daily bag and possession limits are in accordance with the current Texas Parks and Wildlife regulations. In no instance will Fort Hood be less restrictive than the state.

Inks Dam National Fish Hatchery (NFH) will annually provide 3,600 pounds (approximately 12,000) Channel Catfish in legally catchable sizes for Fort Hood's "Put and Take" fisheries program (see Cooperative Plan Agreement). The fish will be purchased from a commercial source, if Inks Dam NFH is unable to provide them. The "Put and Take" program will facilitate fish management by concentrating the greatest fishing pressure into specific areas. The lakes used for the "Put and Take" program will be:

1. Nolan	5. Airfield	9. Copperas Cove #3
2. Heiner	6. Bratcher	10. Cantonment A
3. Larned	7. Cantonment B	
4. Engineer	8. LTA 201	

Cantonments A and B will receive 30% of the annual fish stocking; the remaining 70% to be distributed among the other designated lakes. In addition to "Put and Take" stocking, a number of lakes will be stocked with Largemouth Bass, Channel Catfish and Bluegill in order to develop or maintain stable fish populations. Generally speaking, these fish will be either fingerlings or brooders provided by a variety of sources. Fort Hood impoundments will be stocked for this purpose once the need has become apparent, but the following lakes will receive the greatest emphasis:

22B	34C	34A
Airfield	35K	
44E	Stampede	
33C	33G	

New lakes plus the lakes scheduled for complete renovation will receive entirely new stocks of fish pending lake refill.

Lakes with concentrations of rough fish exceeding acceptable limits will undergo pesticide treatment with Rotenone. Such lakes must exhibit 75% sunfish, 25% bullhead catfish or 10% carp of total fish biomass to warrant Rotenone application. However, the lakes that are scheduled for renovation will be treated with Rotenone in conjunction with lake drainage procedures. Some measure of rough fish control will result from routine sampling surveys. Rough fish captured by use of fish traps, gill nets, seines and electroshocking will be discarded at survey completion.

Fort Hood will not engage in intensive fish culture management in the out-years. However, the ponds known as East Lake and 90A will be set aside as Bluegill nurseries to provide forage fish stock for other Fort Hood impoundments. Management efforts will be limited to periodic removal of competitor and predator species, vegetation control and harvesting the standing crop for reintroduction into other waters.

Furbearer Management

Furbearer surveys will be conducted in conjunction with the deer spotlight drives. The census data will be compiled, analyzed and forwarded to the Texas Parks and Wildlife Department for harvest recommendations. Harvest recommendations will normally follow state law.

Other Non-game Species Management

Management of non-game species are managed in conjunction with populations of game species. There are no management plans for any particular species.

Transplants and Stocking

Fish Stocking

Largemouth Bass Stocking

Largemouth bass are stocked to supplement depleted/out of balance populations and in newly built or renovated ponds. Supplemental stocking may be any range of sizes dependent on the need identified. New stockings will primarily be fingerlings. In both situations the purpose of stocking is to maintain or establish balanced populations within a pond.

Channel Catfish Stocking

Channel catfish are stocked in many of the installation ponds. Annually, catfish are stocked in some of the more popular fishing lakes to provide greater angler opportunities. The annual "put and take" stockings facilitate fish management by concentrating fishing pressure into specific areas.

Rainbow Trout Stocking

When funding permits, rainbow trout are stocked into 2 installation ponds to improve winter angling opportunities. The "put and take" stockings of trout comply with EO 11978. [The non-indigenous trout are not a threat to the Fort Hood ecosystem. Anglers catch and keep most of the fish and the few that may survive to May, usually will not survive the summer water temperatures. Both ponds design essentially prevent escape into the larger Fort Hood watersheds.]

Forage Fish Stocking

The stocking of forage fish, such as bluegill, redear sunfish and fathead minnows will take place to supplement forage deficiencies in established ponds or to provide forage in newly constructed or renovated ponds. Stocking by sportsmen is prohibited.

Wildlife Stocking

There are presently no plans to reintroduce wildlife species to the installation.

Wetlands and Waterfowl Management

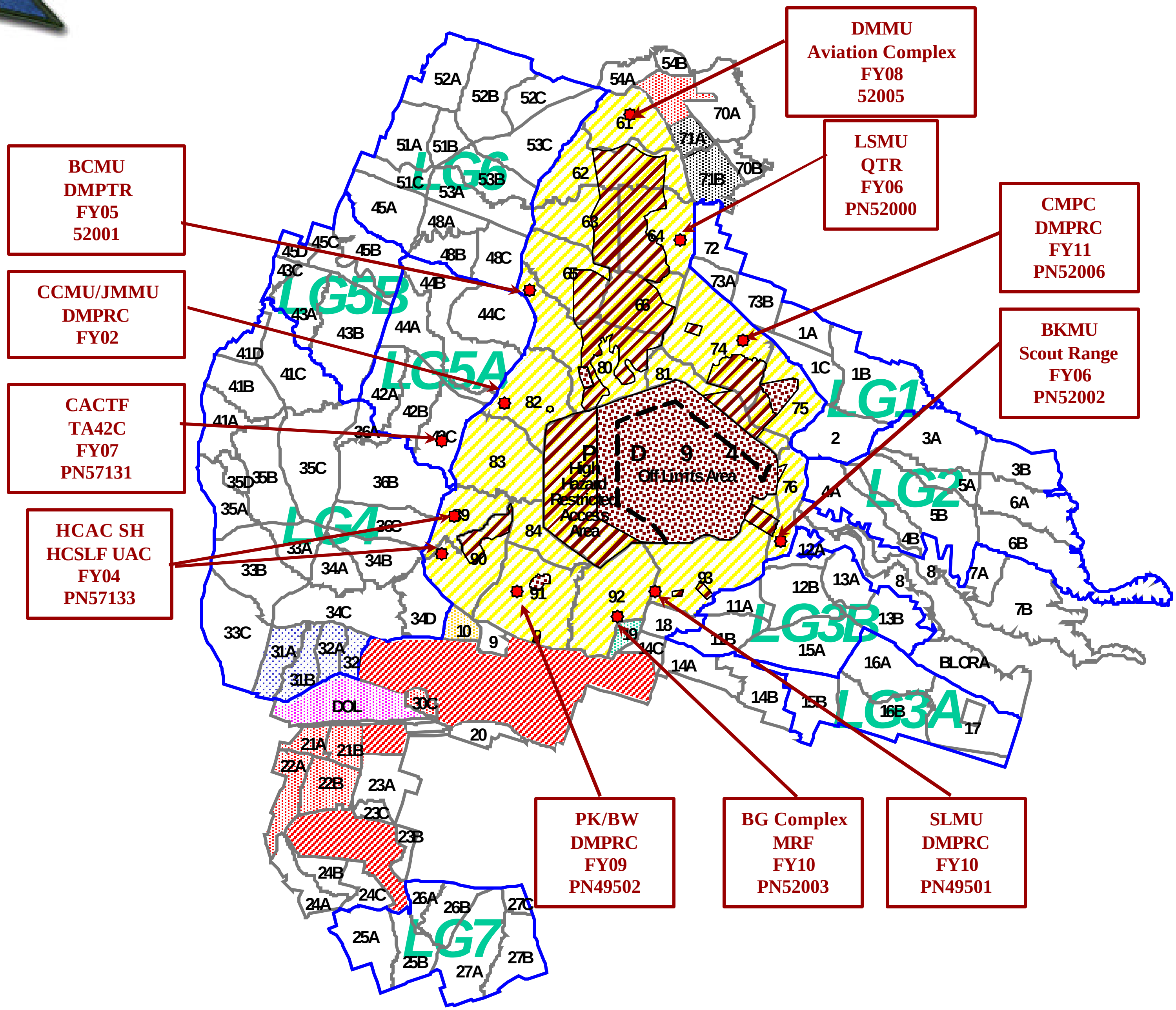
The Fort Hood acreage in wetlands is quite small, although projects for mitigation banking are planned. Also, all lake construction and renovation plans have projects to increase waterfowl use of Fort Hood's impoundments as well as planned “Green Tree Lakes”. These improvements include island construction, increase in shoreline complexity and retention of standing timber in the shallows.

Although waterfowl populations are limited on Fort Hood, several lakes have been improved in the past for waterfowl management by construction of duck blinds and duck potato introduction.

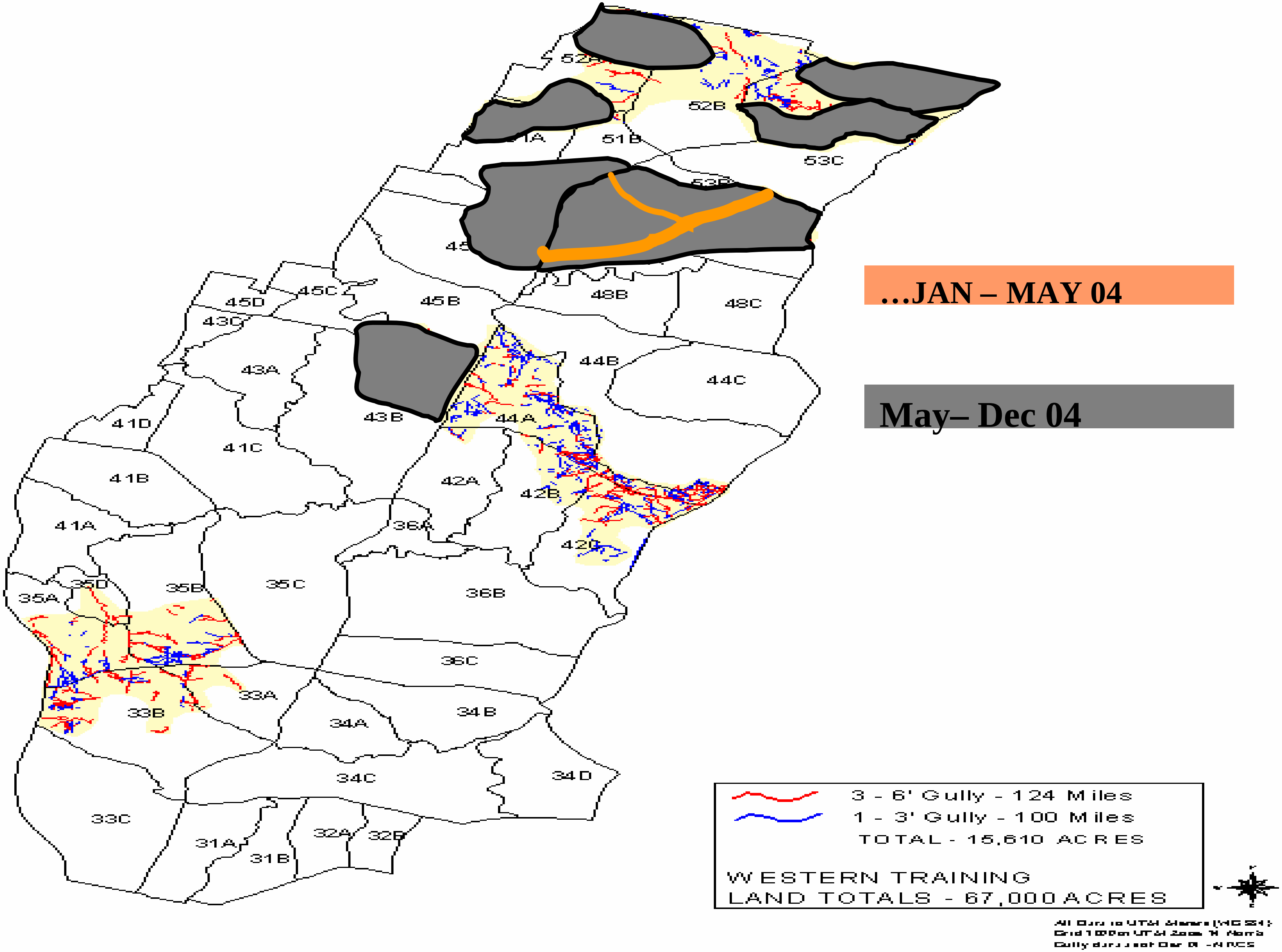
Development of nesting areas for waterfowl use would provide limited success at Fort Hood since the only waterfowl known to nest in this geographical location do so as occasional migrants only. The existing habitat has ample natural nesting sites for the Wood Duck (Aix spoilsa) or Mottled Duck (Anas fulvigula) that may remain on Fort Hood during nesting season.

Sep 2004

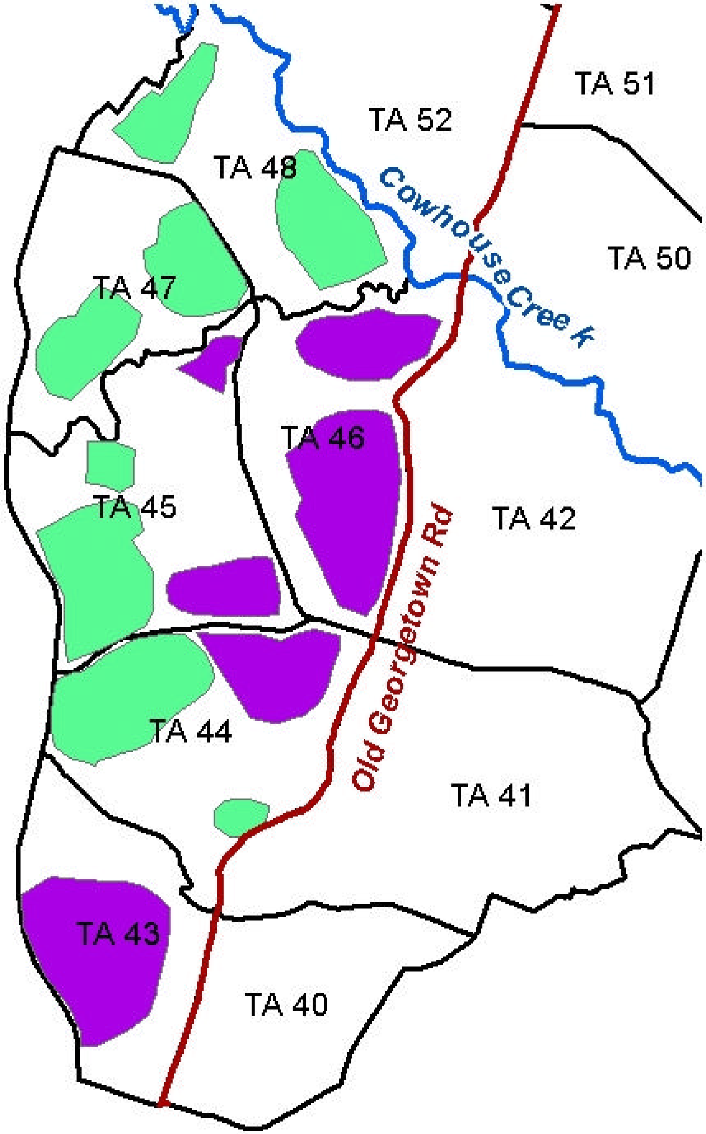
Current AMRP through FY11



TAB I: FY04 TRAINING OUT AREA PROGRAM



TAB I: FY05 TRAINING OUT AREA PROGRAM

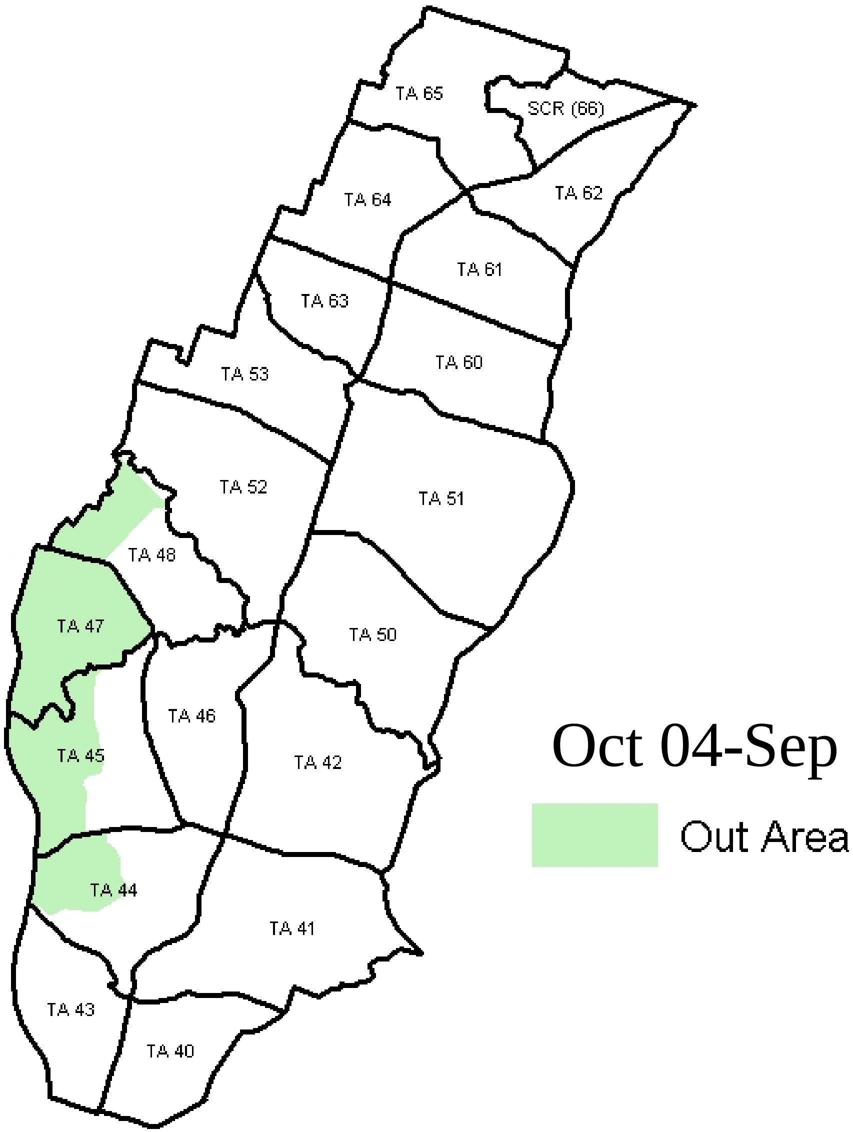


FY05 OUT AREA

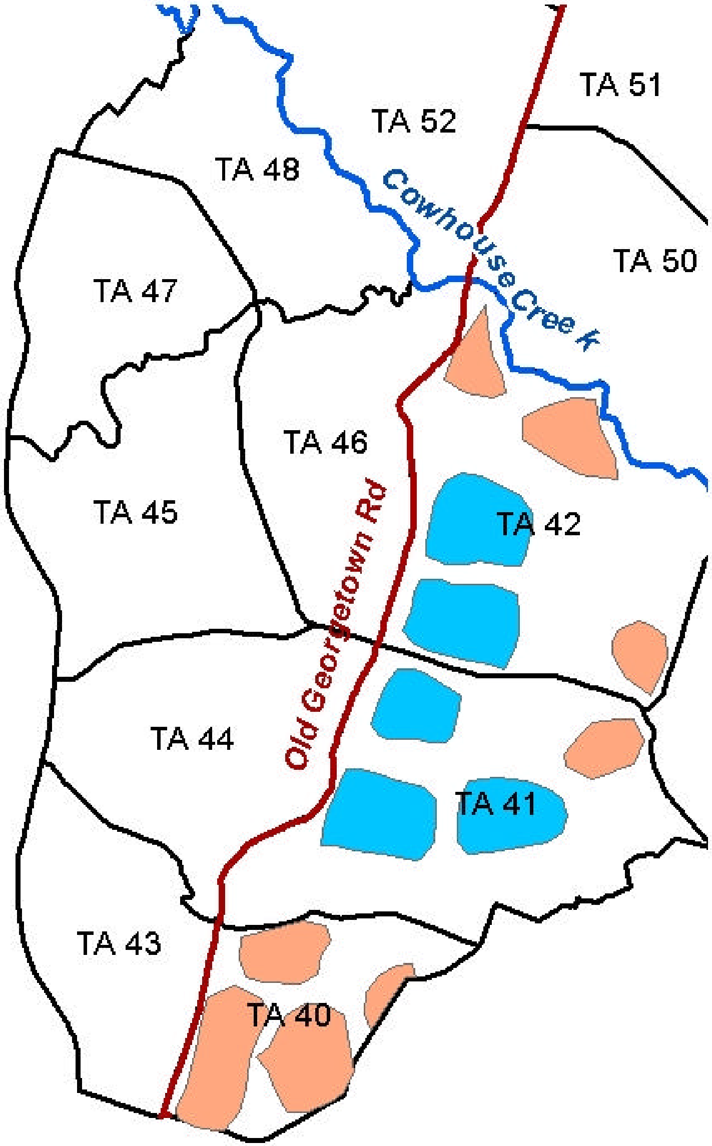
Oct04 - May05

May05 - Sep05

FY05 TRAINING OUT AREA PROGRAM-funded as of 16 Aug



TAB I: FY06 TRAINING OUT AREA PROGRAM



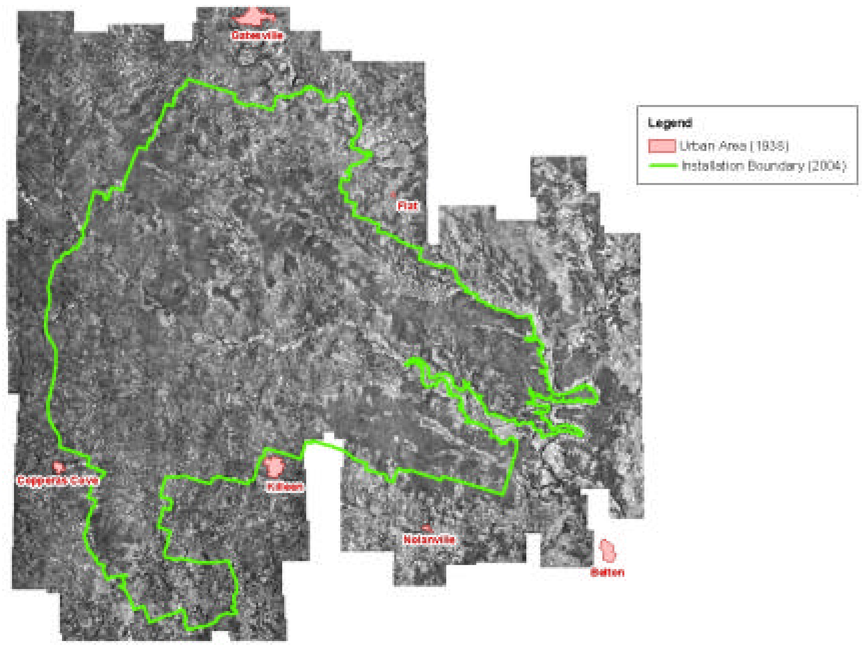
FY06 OUT AREA

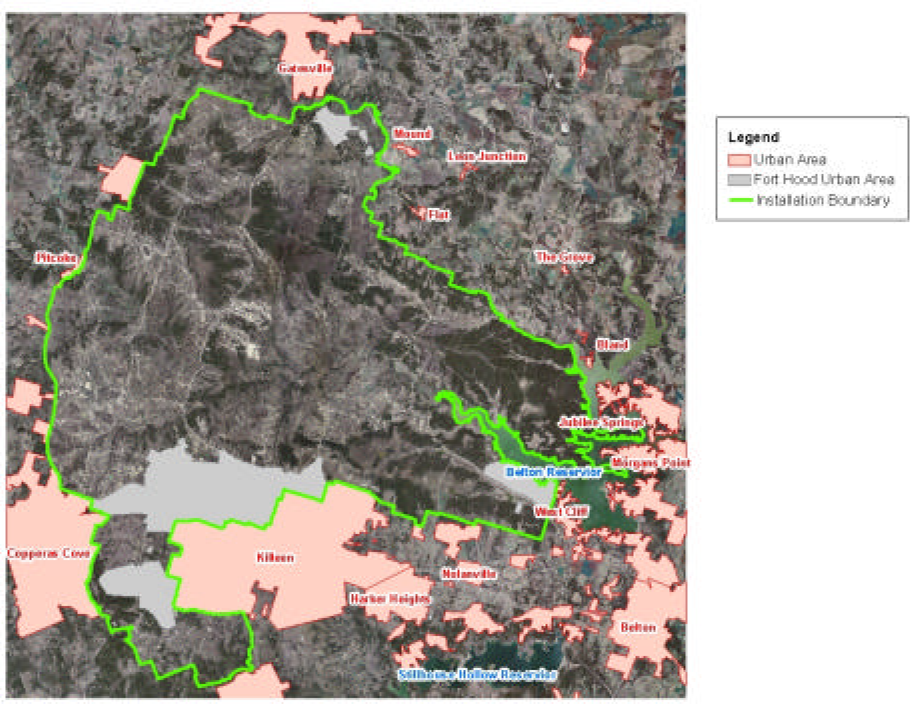
Oct05 - May06

May06 - Sep06

TAB J: Urban Sprawl Awareness

1. No installation is an island. To assess current and future installation training concerns, one must be aware of the off post impacts and trends. The Fort Hood site was selected in 1942 because of its remote location to surrounding communities…that no longer is true. As Hood and its surrounding communities evolve, they impact each other. The second picture is 2004 data.





TAB K :

Maneuver Damage Program (MDP)

Maneuver Damage Program (MDP)

The MDP indefinitely maintains and sustains usable maneuver training areas by

- Reporting environmental damage.
- Programming repair work.
- Land repairing the damage before it becomes worse or costs more.
- Provides guidance to commanders on how to minimize environmental damage but <u>not</u> cause restrictions on maneuver training opportunities.
- Establishes responsibilities and procedures for military units and installation agencies.
- Involves unit Environmental Coordinator to assess any damage found, criticality for timely reporting, and clearing units after training.
- Involves leadership in land stewardship planning, per TC 5-400 (Unit Leader's Handbook for Environmental Stewardship).
- Standardized format for reporting, FH Form 350-X27 (Maneuver Damage Report).
- Establishes unit restoration responsibilities according to Fort Hood Regulation 200-1, before a unit is cleared by the land manager.
- Provides data for trend or repair analysis and prioritizing.

Purpose

To outline policies and procedures of the Fort Hood MDP.

References

AR 200-1, Environmental Protection and Enhancement.
AR 200-2, Environmental Effects of Army Actions.
AR 385-10, The Army Safety Program.
FM 100-5, Operations.
TC 5-400, Unit Leaders' Handbook for Environmental Stewardship.
Fort Hood Supplement 1 to AR 385-10.
Fort Hood Regulation 200-1, Environment and Natural Resources.

Applicability

This program is applicable to assigned, tenant, or visiting command units, individual soldiers, and authorized civilian personnel conducting training on Fort Hood lands and ranges.

General

The goals of the Fort Hood MDP are

- To maintain usable training areas or ranges.
- Comply with Army, DOD, and local, state, and national environmental laws and policies.
- As a long term consideration, minimize damage to the environment in the interest of future generations, and <u>not</u> cause restrictions on training opportunities.

The Fort Hood MDP is

- Aggressive and comprehensive, yet balances against training needs.
- <u>Not</u> intended to restrain maneuver or training.
    - The keys are education, timely reporting of maneuver damage, and repair of damages before it degrades maneuver training areas to where the areas are <u>not</u> adequate for training.
- Units deployed off post will adhere to federal and local regulations when they are more restrictive.
- When local regulations do <u>not</u> exist, or are less restrictive, this SOP is in effect.
- Off-post maneuvers require an environmental impact assessment prior to deployment.
- Prior to major off-post deployments, cover maneuver damage in the OPORD.

- The portions of the program that pertain to chain of command responsibilities are also applicable to III Corps and Fort Hood assigned units when deployed for training.

- The MDP will not require additional personnel.

- Units will appoint personnel to additional duties (AR 200-1 and Fort Hood Regulation 200-1).

The executive officer at each organizational level should be the unit environmental coordinator.

The program is designed to make environmental protection and enhancement a chain of command goal.

The unit chain of command monitors and enforces preventive or corrective measures.

The MDP is comprised of five essential components.

- Education and Prevention.

- Reporting.

- Correction and Repair.

- Fixing Responsibility.

- Evaluation of Effectiveness.

H-5-4

Responsibility

DPTM

- Is the staff proponent for this program.

- Arbitrates, within the spirit of this program, any conflicts arising between Range Control and a unit.

- Develops and implements a standardized Mission Data Report (MDR) for Fort Hood units.

- Develops a system for reporting periods of maneuver restrictions to units in the field.

- Provides Reserve Components with periodic updates affecting maneuver.

- Coordinates and publishes maneuver damage and environmental work projects in the III Corps LRTC and GSP.

The ACofS, G5, will serve as POC for any aspect of damage associated with off-post training.

Range Control will

- Provide incoming land group manager's Maneuver Damage Control Officer (MDCO) with a copy of the land group's maneuver damage sites, prior to occupation.

- Inform new land group MDCO that damage not already registered must be reported.

- Provide copies of maneuver damage and utilization reports to DPTM and DPW, as applicable.

- Assist DPW in planning, scheduling, cost analysis, LRTC updating, and repair of training lands.

- Update land managers on off-limits, restricted use, repair projects, and sensitive area changes.

- Monitor excavations on training lands.

The III Corps Reserve Component Affairs Division will:

- Ensure all Reserve and National Guard units scheduled to train at Fort Hood receive an MDP training packet with adequate time for proper training prior to arrival at Fort Hood.

- Ensure RC unit arrives with their Maneuver Damage Repair Team (MDRT) equipment requirements.

- Review the RC unit's inclement weather training plan pertaining to land use restrictions.

DPW will:

- Develop education and training programs including certification criteria, for Maneuver Damage Control Officers (MDCOs) and Maneuver Damage Repair Teams (MDRTs).

- Certify and train all MSC, separate battalion, and company MDCOs, according to AR 200-1, paragraph 1-25 and TC 5-400, paragraph 3-4.

- Maintain statistics on all maneuver damage reportable incidents and their costs.

- Assist in developing updated training maps with current restrictions and environmentally sensitive areas.

- Monitor and suggest modifications (through DPTM) to the parameters (scope and limits of work) of unit MDRT activities.

- Suggest equipment requirements based on mission and organic capabilities of each type of unit.

- Coordinate and recommend land use restrictions, to include impact of inclement weather, on training.

- Maintain and analyze statistical data including costs on maneuver damage.

- Assist in the planning, programming, and scheduling of rehabilitation or repair of land projects in the LRTC.

- Provide assistance and operational control of military engineer assets to correct major maneuver damage beyond a maneuver unit's capability.

- Contract support to meet rehabilitation schedules.

- Furnish dollar estimates for rehabilitation work.

- Provide updates and status on ITAM projects, including:

    - Cost overruns.

    - Initial and changes to work project dates.

    - Projected and final work completion dates.

    - Initial and changes to prioritizing of work.

    - Projected fund shortages or overages.

    - Alternate work projects.

    - Projects for upcoming years and funds.

MSC and separate battalion or company commanders

- Ensure land manager headquarters maintains a current maneuver damage overlay that shows maneuver damage from subordinate units including
- Slice.
- Support.
- Joint use.

- Forward consolidated maneuver damage reports and overlay to Range Control at the end of a unit's management.

- Land group and training area managers or MDCOs will ensure maneuver damage is documented prior to issuing clearance to subordinate and joint use unit(s).

- Be responsible for unit compliance with the regulations and laws regarding environmental protection and enhancement.

- Appoint, on orders and down to company level, MDCOs and MDRTs.

- Supervise the MDCOs and MDRTs.

    - Ensure they are properly trained and certified according to AR 200-1, Fort Hood Regulation 200-1, and DPW training.

- Establish an internal MDP (to include a written Maneuver Damage SOP) within their units.

    - Ensure the SOP includes a system of maneuver damage reporting.

- Ensure that units comply with clean up or repair directives, Fort Hood Regulation 200-1, and appendixes in Fort Hood Regulation 350-40, before clearing or departing the training site.

- Develop and implement an inclement weather - training program based on current land use restrictions.

- Ensure that coordination has been accomplished through DPTM to fulfill requirements responsibilities specified in this MDP prior to deployment for maneuver training.

The MDCO

- Attends environmental and management training provided by DPW (Fort Hood Regulation 200-1).

- Schedules Maneuver Damage briefings prior to III Corps MSC level exercises.

- Trains and certifies subordinate MDCOs, MDRTs, and unit personnel.

- The MSC MDCO can certify subordinate unit MDCOs, using DPW training materials.

- Investigates maneuver damage incidents and reports them to Range Control, using a Fort Hood Form 350-X27.

- Writes their unit's Maneuver Damage SOP.

    - Include a system for maintaining or submitting the Maneuver Damage overlay and compiled MDRs to Range Control.

- Writes the maneuver damage prevention portion of unit operation orders and training plans.

- Advises unit commander and staff on maneuver damage issues.

- Supervises employment of MDRTs.

Although the commander is responsible for the overall MDP, individual soldiers may be held personally responsible and pecuniarily liable if the environmental damage is due to negligence or willful misconduct.

H-5-5

Education and Prevention

Commanders at all levels are responsible for the training and education of all soldiers in their command on maneuver damage, environmental protection, and environmental awareness.

This regulation establishes the minimum education and training requirements under the MDP.

- The DPW will develop an education and training program (ETP) for specific target audiences which will consist of

    - Separate education and training with video.
    - Materials.
    - Environmental courses taught by DPW.

- Develop separate ETP materials for

    - Commanders and Unit MDCOs.
    - Officers and Senior NCOs.
    - Staff Officers and NCOs.
    - MDRT.
    - Enlisted soldiers (SSG and below).
    - Inprocessing personnel.

- Design an education and training program to foster environmental consciousness and focus on individual and unit responsibilities at levels listed above.

- Briefings and videos should focus on preventive measures units can take to preclude maneuver damage that includes

    - Proper driving techniques.
    - Pollution prevention.
    - Basic rules for environmental protection.
    - Garbage handling.
    - Area police.
    - Off limits and restrictive area markings.
    - Endangered species and wildlife protection.
    - Field sanitation.
    - Installation specific issues.
    - Problems identified by all coordinating activities and units.
    - How environmentally sound procedures can also be tactically advantageous.

- The ETP for commanders, leaders, and MDCOs will include

    - A description of responsibilities and authority.
    - Site inspection methods and procedures.

- Reporting procedures.
- Possible punitive actions for non-compliance.
- MDCOs must attend biannual refresher training to maintain their certification.

Units should

- Schedule a Leaders' Environmental Orientation prior to conducting MSC or larger exercises.

- Incorporate Maneuver Damage Prevention as a part of their planning or orders training process.

Maneuver Damage Repair Team (MDRT)

- Each company size or larger unit should organize, appoint, and equip organic MDRT comprised of two NCOs (one staff sergeant and one sergeant) for each company, who will provide leadership for soldiers, detailed by units, to correct or repair maneuver damage.

- The MDRT team should deploy with the unit and remain with the unit for the entire deployment.

- Assignment to an MDRT is an additional duty.

- The unit MDCO will train the MDRT.

- The MSC MDCO.

- Conduct annual refresher training.

  - Conduct training prior to MSC level exercises.

- Duties of the MDRT are covered under Repair, H-5-8.

H-5-6

Reporting

At least 4 days prior to taking control of land, the unit MDCO should verify the land(s) resource and get a copy of the relevant Mission Data Reports (MDRs).

- Range Control will identify any new, protected, restricted, or off limits areas and pre-existing damage sites.

- The unit discovering or causing maneuver damage will report the damage to their MDCO.

- The MDCO will assess the damage to determine if MDRT(s) can repair the damage with organic assets.

  - If the damage is outside the unit's repair capability or poses an immediate threat to the environment (for example, a major POL spill or POL entering a water system), the MDCO will report the damage IMMEDIATELY to Range Control on the MDR.

- Range Control will forward the report to DPW, who will dispatch an inspector to the site.

- DPW will verify the situation and determine what further action is required.

- Units will submit compiled MDRs and damage overlay to Range Control upon termination of land manager duties (NLT 48 hours).

IMMEDIATELY REPORT

- Hazardous material spills of any quantity.
- Petroleum, oil, and lubricant (POL) spills greater than 25 gallons.
- Spills covering more than 100 square feet (10 x 10).
- Spills that enter or threaten to enter water networks or systems.
- Immediately contact Range Control by radio (30.45/38.30) or telephone (287-3321).
- The MDCO will fill out an MDR for each incident of damage that the MDCO determines is within unit repair capabilities and submit it to Range Control at final clearing time frame.
- Annotate repaired sites on damage overlays in a different color than sites not repaired.

Civilians living adjacent to Fort Hood, or whose land is used for off post training, who discover an accident or incident on their property, should notify the III Corps ACofS, G5, or the Corps Operation Center (after duty hours).

- The G5 will notify the DPTM.
- The unit that is or was maneuvering in that area will be notified of the discovery.

Commanders should ensure that a record is kept of the condition of the land group or training area upon initial ownership and final departure.

- Maintain the data for 6 months.
- The unit MDCO should assist in clearance inspections and maintain maneuver damage records.

H-5-7

Correction and Repair

The unit MDCO controls MDRTs and will respond to maneuver damage incidents within the unit's area of responsibility.

The MDRT will use organic personnel and transportation assets.

The MDRT need not be a full time, dedicated force, but should be able to respond timely to repair requirements.

Each MDRT will have the following equipment readily available.

Equipment	**Quantity**	**Equipment**	**Quantity**
spill sorb	100 pounds	engineer tape	1 roll
broom	2 each	pickets	20 each (fence repair)
shovels	2 each	barbed wire	1 roll (fence repair)
rakes	2 each	trash bags	50 each
trash cans (32-gallon)	2 each		

Due to the size of the MDRT, it will only conduct such limited repairs as

- Clean up of POL and toxic spills of 25 gallons or less.
- Remove and replace damaged soil and trees with technical assistance from the DPW.
- Fill in small (2 feet or less in depth, and length of 30 feet or less) trenches or ruts, or up to and including 20 foxholes or individual fighting positions.

If a unit occupying an area discovers excessive maneuver or environmental damage

- Submit MDR immediately.
- The unit should mark off the area and take measures to prevent further damage or safety incidents.

Immediately report

- Hazardous material spills of any quantity.
- POL spills exceeding 25 gallons.
- Spills covering more than 100 feet.
- Spills that threaten to enter water systems/drains.

H-5-8

Fixing Responsibility

If maneuver damage occurs, and unit MDRTs can fix the damage, the MDCO will complete an MDR, place the site on the overlay, and take no further action.

If maneuver damage occurs and cannot be repaired by MDRTs, and damage is fair wear and tear, DPW will

- Investigate the damage.

- Ensure unit MDRTs have performed all repairs within their capabilities.
- Determine the Estimated Cost of Damage (ECOD) for remaining damage.
- Establish priority for repair.
- Program repairs into the Conservation or ITAM repair plans.

If maneuver damage occurs, and negligence or misconduct is suspected,

- Range Control will notify the responsible unit, DPTM, and DPW.
- DPTM will arbitrate disputes for damage between Range Control and the unit of responsibility.

- If arbitration fails, the unit may appeal to the Chief of Staff (CofS).

- The CofS, in coordination with the Garrison Commander, will render a decision either fixing or directing the unit's higher headquarters to initiate a survey investigation.

- DPW will provide an ECOD to the investigating officer.

- In the case of a visiting reserve unit, the ECOD will be sent to Reserve Components Support (AFZF-RC).

- Follow the provisions specified in the current Supply Update for affixing responsibility or determining liability.

- If a survey investigation is initiated and pecuniary liability is determined, the CofS, in coordination with the Garrison Commander, can transfer funds from the responsible unit to the correcting agency(s) to cover the costs for correcting the damage.

- If a unit is found pecuniary liable, they will have 10 days to review the cost for correcting the damage before a transfer of funds occurs.

- If a reserve component unit or individual is found liable, DPTM, Reserve Affairs Division will forward the appropriate supply documentation to the State Adjutant General or Army Command (ARCOM) Commander.

- The state or ARCOM will provide a Military Interdepartmental Purchase Request (MIPR) NLT 15 days after receipt for the amount equal to the costs of correcting the damage.

H-5-9

Evaluation of Problems

Principal MDP activities, DPTM, Range Control, DPW, Reserve Component Support Division (RCS), MSCs, and III Corps should meet at least semiannually to evaluate this MDP and identify systemic problems or important topical issues.

Users may send written comments or suggestions to improve this pro-Gram to the Range Control, ATTN: AFZF-GTT-RG.

H-5-10

TAB L :

Sustainable Range Awareness Program (SRA)

SRA

This program educates commanders, staffs, leaders, soldiers, and other land users on environmental management of Fort Hood lands.

H-2-1

Basis

SRA is founded in institutional environmental training by Army schools, augmented by Fort Hood Schools and DPW courses.

H-2-2

Basic Elements

The ITAM Sustainable Range Awareness Program consists of three elements.

- Training and educational material.
  - Installation Awareness videos.
  - Posters.
  - Handouts.
  - Maps with environmental sensitive information.
  - Booklets and cards.
    - Leaders.
    - General information.
    - Fort Hood-specific general information.
- A plan for SRA training implementation.
  - Unit Environmental Coordinator training.
  - Unit level organizational training.
  - Use of DPW classes and orientations.
  - Incorporation of SRA in
    - Fort Hood administrative publications and operations plans.
    - Unit SOPs.
    - Maneuver planning.
    - Operational orders (OPORDs) and overlays.
- Command emphasis
  - Most visible to soldiers.
  - Soldiers do well on what leaders inspect.
  - Conveys focus and resolve of leaders on SRA.
  - Conveys the seriousness of environmental and land stewardship.
  - Awareness replaces ignorance and reduces non-compliance litigation and costs.
  - Enforces leadership standards as soldiers advance in the Army.

H-2-3

TAB M: Tank Trails

1. The installation trail network provides trainers access throughout the installation to conduct training and minimize road use by tracked vehicles. Fort Hood has 400 miles of trails in the maneuver training lands, of which 90% are unserviceable or require moderate to severe repairs.

2. The trail conditions impact soldiers and training safety, training events, create environmental concerns, and training land capabilities and infrastructure.

a. Unsafe trails increase safety incidents. Accidents, injuries, and vehicle damage and repairs are the result of unserviceable trails.

b. Unserviceable trails impact training by limiting access to terrain, narrowing maneuver unit’s capabilities to conduct training in training lanes, and limiting areas where units can conduct safe night training. Training often result in damages to vehicles, turning maneuver training into recovery training, and increasing training resources spent on repair parts and maintenance.

c. Unserviceable trails impact the environment. Trainers bypass unserviceable sections and damage the surrounding landscape. On wet days, the bypassed trail can have 100 meters wide bypasses. This damage results in bare, disturbed ground that is highly erodeable. 61% of the installation’s concentrated erosion is associated with the unserviceable trail network. Tons of soil and sediment migrate down the water sheds and into the stream networks and part of this sediment moves off post into surrounding lands and into the Belton Lake Reservoir. As the concentrated erosion moves, it creates gullies, cliffs, and drop offs in the landscape, compounding erosion, safety, and training concerns. Stream banks disappear stopping access to crossings and training lanes. Increases of sediment deposits in the mouth of Belton Lake are discernable and measurable. A 13 acre sediment deposit (growth) was measured in one area over a five-year period.

d. Unserviceable trails impact and degrade training land infrastructure and increase maintenance and repair costs. The traffic must go somewhere. Untrafficable trails move the traffic to the shoulders. Once that's unserviceable, they create new trails over the landscape but are tied into stream crossings and hilltop access trails. Once those become unserviceable, new trail are created by traffic. The new trafficked trails are sometimes on

and damage water lines and fiber optic lines. Once all of above become unserviceable, the only training movement route left is the paved and all weather roads and crossings on bridges and erosion structures. Roads and their shoulders are damaged during movement and training, further degrading the infrastructure.

3. To resolve these concerns, a trail plan was designed to fix and maintain the 400 miles of trails on the installation. The plan identified the requirements for single and double lane primary trails and secondary trails throughout the landscape.

4. DPW, Master Planning is responsible for upgrading 9 miles of double lane primary trails and 171 miles of single lane primary trails. DPW, Natural Resources is responsible for upgrading 187 miles of secondary trails. ITAM is responsible for upgrading 33 miles of secondary trails and adding the trails to the property book. DPW, Real Property is responsible for adjusting the property books and annual maintenance on the 400 miles of trails.

5. Once the trail network is upgraded, Real Property maintains them. Conservation and ITAM will repair training damaged sections to sustain the network. Units are to report damaged sections by submitting Maneuver Damage Reports to Range Control. ITAM and Conservation will use the reports to plan, budget, and repair the training damaged section.

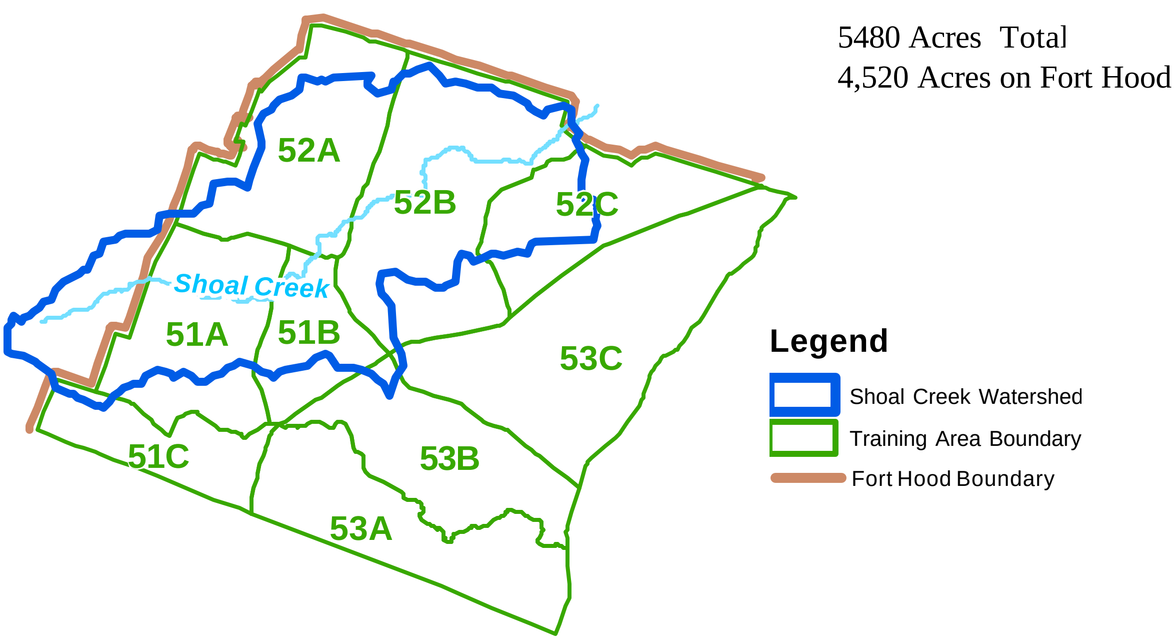
TAB N: SUSTAINING THE FORT HOOD LANDSCAPE TO PROMOTE EFFECTIVE MANEUVER TRAINING AND CLEAN WATER

Desirable water quality and military maneuver training are not usually thought of as being compatible. However, monitoring of the effects of land restoration best management practices (BMP's) installed in a pilot watershed within Fort Hood training lands is showing both to be attainable.

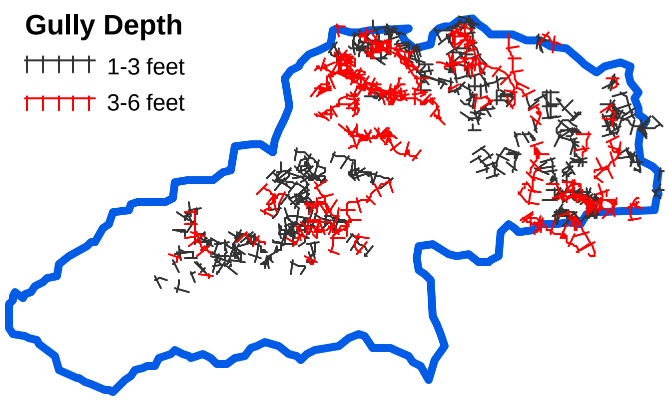
The Shoal Creek watershed consists of 5,480 acres. Approximately 82%, or 4,520 acres of the watershed are within Fort Hood Training Lands. The remaining 960 acres are in the upper reaches of the watershed and are privately owned rangeland. This watershed is a part of training area nos. 51 and 52 in the northern section of Fort Hood's main heavy force maneuver lands. It is heavily used by tracked vehicles for task force maneuver and training lanes and is used in conjunction with adjacent live fire ranges. This area also contains an inert (25 lb.) fixed-wing bombing range. Other land uses include cattle grazing and recreational uses such as hunting.

The soils are calcareous, shallow to moderately deep, clay loam, and the topography is a rolling prairie with slopes ranging from 1 to 8%. The native and adapted vegetation is perennial species such as Little Bluestem, Oldworld Bluestems, Indiangrass, Switchgrass, Sideoats Grama, Tall Dropseeds and Buffalograss.

Shoal Creek Watershed



Heavy use by training and other users had left the land severely compacted and void of perennial vegetation in many areas, causing the development of numerous gullies. There were 22 miles of gullies, which were 1-3 feet deep, and 19 miles of gullies, which were 3-6 feet deep.



Gully Depth/Length (miles)

Depth	LENGTH
1-3 feet Total	22.2
3-6 feet Total	19.3
Grand Total	41.5

These gullies impact training by causing movement/time-table delays, restricting maneuver training lanes, and limiting access routes through lanes during training exercises. They posed safety hazards for soldiers, added to equipment damages/repairs costs, and took resources and time away from training units. Instead of maneuvering according to the training plan, vehicle drivers had to slow at each gully, search for a crossing site, or go around the gully to continue the training plan, and do the same at the next gully. This was incorrectly teaching inexperienced crews to present their flank and rear to the enemy. Occasionally vehicles became stuck and overturned in the gullies.

TANK CRASHED INTO 5 FOOT GULLY

TANK SLIPPED INTO GULLY

TRAINING COSTS: INTERUPTED TRAINING – PERSONNEL INJURIES – VEHICLES DAMAGED

To correct these problems the ITAM personnel worked with the Command Group and the Directorate of Public Works to formulate the Training Out Area Program to close the training areas within this watershed for two growing seasons from military training and to defer cattle grazing while corrective measures were put in place. The conservation expertise of the USDA-Natural Resources Conservation Service was utilized to design and install the practices. The practices planned (or BMP's) were a combination of the following:

- Mechanical soil treatment, or sub-soiling to a depth of 24 inches @ 6 feet on center on the contour, to alleviate the soil compaction. This allows percolation of water and air into the soil profile to aid vegetative growth.

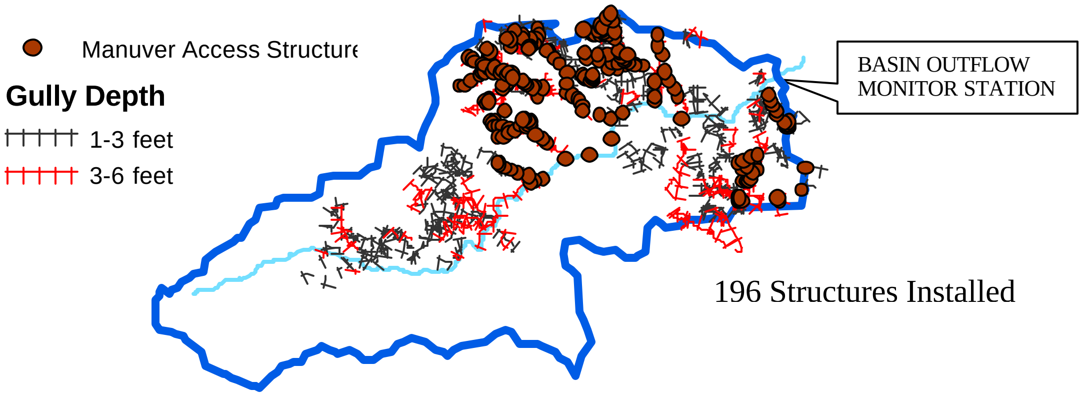
SUB-SOILING

ON CONTOUR

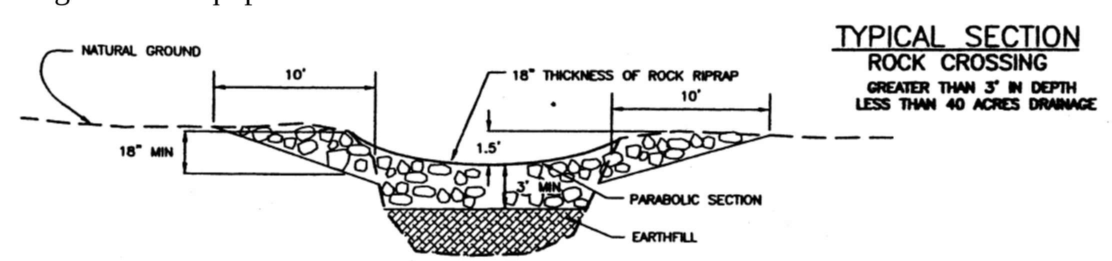
- Seeding native and adapted perennial grasses where seed sources were not adequate to naturally re-establish a desirable vegetative cover, which would reduce soil erosion to acceptable levels and help support frequent training requirements.

HEALING GULLIES WITH MAS'S & GRASSES

Maneuver Access Structures



- Installing maneuver access structures (MAS) in the gully network. These structures are constructed with selected rock varying in size from 4 – 12 inches in diameter. They are constructed to form a weir in the channel to keep the flow of water in the center of the gully. They are placed in a stair-step method so the elevation of the top of one is level with the tow of the one above. Eventually the once deep gully will fill with silt, starting on the upstream side of the MAS, and become a stair step down the slope. These structures are also placed in line, as much as possible, across the slope to enhance the flow of maneuver traffic. Trainers have accepted and used the MAS's. They say that they are great to enhance the flow of maneuver. During night maneuvers, the MASs are visible to maneuvering units as they retain heat from the day and allow them to be seen with night vision equipment.



Note: Typical drawing applicable to Fort Hood only. Drainage area/expected flow to be verified prior to installation.


MAS IN GULLY


M-1 CROSSING MAS

1 YEAR = 1 FOOT OF SILT

REDUCED EROSION, SEDIMANT BUILD-UP AND VEGETATION IMPROVEMENT

Storm water runoff and associated sediment loss of this area have been continuously monitored in Fort Hood's Shoal Creek watershed by the Blackland Research and Extension Center's Water Science Laboratory (BREC), a part of the Texas A&M University system, since 1997. The monitoring equipment included an ISCO 4230 Flow Logger, a rain gauge and an ISCO 3700 Automated Storm Water Sampler at the basin outflow. Storm water samples are analyzed gravimetrically for sediment concentration and combined with flow measurements to determine the sediment load associated with individual storm events.

To date, 22 pre-BMP events and 18 post-BMP events have been measured. For this evaluation, accumulated rainfall totals over a 24-hour period were plotted against the measured sediment load for individual storm events. A linear fit of the data shows a large reduction in sediment loss due to BMP implementation. A regression slope comparison using student's 't' test indicates a statistically signinficant difference between the mean sediment loss pre-verses post-BMP implementation. Evaluation of these BMP's using the Soil and Water Analysis Tool (SWAT) computer model yielded similar results. The model predicted sediment load reductions ranging from 62 to 95% depending upon location in the watershed. Actual results have proven better than expected.

In areas of concentrated flow (gullies), pre-BMP soil movement ranged up to 250 tons/acre/year. Soil movement from sheet and rill erosion ranged up to 20 tons per acre. The post-BMP mean sediment load at the outflow point for an average of the entire watershed has been reduced by 98%.

Greater soil infiltration, better vegetative cover and the rock check dams allows more of the rainfall to remain in the soil profile. Less runoff equals less soil being transported into streams and off site into public water sources.

The combination of deferment, installed practices and favorable rainfall allowed an adequate vegetative cover to become established. The gullies have stopped eroding, are filling with silt above the MAS's. Perennial grasses have begun to grow in and around them. So instead of gullies getting larger and more of a problem, they are getting smaller and the landscape is providing a more desirable environment to support training requirements.

The land sustainment goals of this effort were to:

1. Improve the training landscape
2. Enhance readiness training capabilities
3. Reduce training obstacles in the primary heavy maneuver training lanes
4. Reduce soil erosion rates
5. Improve vegetative cover
6. Provide an environment that will remain viable to support current and future maneuver and readiness training
7. Improve the water quality both on and off the Installation

These objectives are slowly being met, as we apply the BMPs across the heavy training landscape, based on the availability of funding. These BMPs best support training and water quality. Soil conditions and grass cover are being improved, the erosion and sediment movement have slowed within tolerance (T) levels, and the water quality is much improved. With continued proper training land management the vegetative cover and land conditions can be sustained, allowing the training lands to remain viable for the future users and the water leaving the installation will continue to be clean. Like we say in Texas, "Good fences and clean water help make good neighbors".

DATE: 22 April 2004

AUTHORS:

FORT HOOD:	Mr. Jerry Paruzinski, ITAM Coordinator Mr. Don Jones, LRAM Coordinator Mr. Dennis Herbert, DPW, Natural Resources
USDA-NRCS:	Mr. James Alderson, Plant Materials Specialist / NRCS Fort Hood Liaison Officer
TAMU-BREC:	Dr. Dennis Hoffman, Research Scientist

TAB O: Fort Hood Juniper Management Program

In 1996, Fort Hood initiated a juniper management program to reopen training lanes/land that were choked with invasive juniper. The reduction of live fire training by the Army shifted training to realistic, non-live fire systems to sustain unit readiness. Training units shifted to TADSS to simulate live fire during training exercises. TADSS are degraded by thick, uncontrolled, spreading juniper on prairies and maneuver lanes. Fort Hood spent millions for TADSS and additional millions of dollars, in equipment, are inbound to the installation. Additionally, juniper reduced visibility and impacts long range engagements during training exercises. The program was staffed and supported by training and DPW.

The Juniper Management Program is divided into three parts:

Level I: Mechanical clearing,
Level II: Non-ground disturbance clearing, and
Level III: Prescribed burning.

Fort Hood spent $4.5 M on Level I, mechanical clearing and cleared 37,052 acres to enhance training.

Level II was not cost effective and was not initiated.

Level III, prescribed burning, falls in two categories:

Burning of brush piles (to support maneuver training)
Regional prescribed burning.

Units submitted a prioritized burn plans to open up constricted areas and support maneuver training. DPW, Natural Resources and Fire Department burn brush piles as weather and resources permit.

A regional prescribed burning plan requires cattle grazing deferments to produce fine fuel loads to carry the fire. Prescribed burning rotates large sectors to control young juniper on a continuous basis.

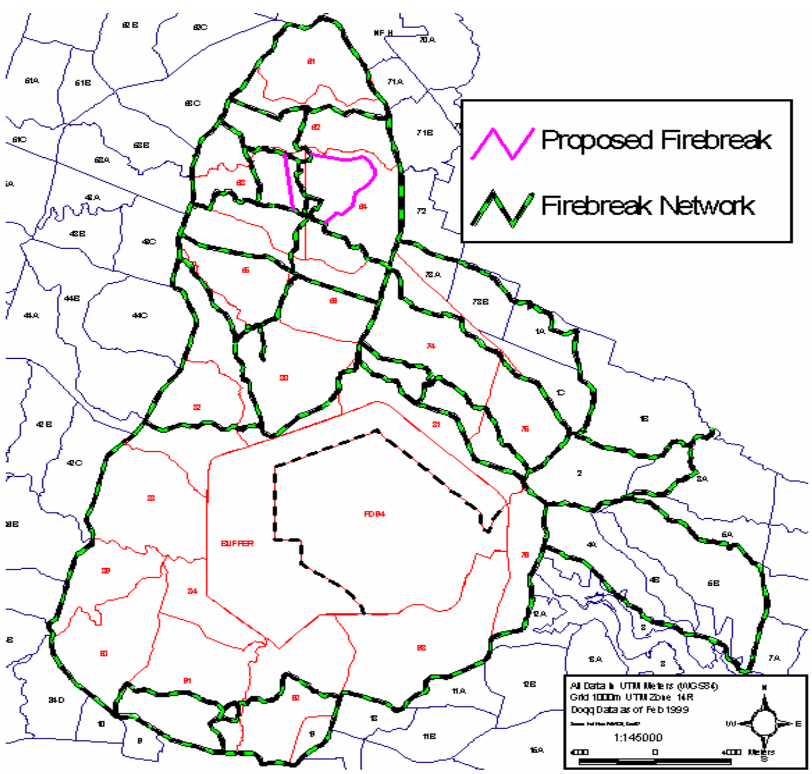
DPW must be resourced to conduct regional prescribed burns to manage invasive juniper or it will again reclaim valuable training land, impact training, and squander limited resources by spending additional millions to mechanically re-clear juniper in the following decades.

TAB P: SUBJECT: Fort Hood Firebreak Program

PURPOSE: To provide information on the Firebreak Program.

In 1996, there were massive fires on Fort Hood, which destroyed over 10,000 of endangered species habitats. Massive fires were recurring on Hood in 6-10 year cycles. Fort Hood agreed with the U.S. Fish and Wildlife Service to increase the military units' fire fighting responsibilities and to construct a network of roads for firefighters to stop habitat-endangering fires inside the live fire area.

In FY97, ITAM prioritized $150K to start the firebreak network program. The firebreak network integrates paved, secondary roads and firebreak trails around/in the live fire area and primary core habitats to provide an access network system to fight fires. DPW approves all trails before firebreak construction starts and performs firebreak network maintenance. The firebreak network benefits training by allowing rapid fire fighting access to remote sites, area compartments to limit fire spread, and decreases range and training down time by minimizing soldier and fire department time spent fighting fires. There are 130 miles of roads/firebreaks in the Fort Hood Firebreak Network.



Construction and maintenance of these unsurfaced roads/firebreaks must be programmed on the GSP as work may conflict training on specific ranges. Spring and Fall clean up weeks provide the best time for grading with minimal impacts to training.

The Henson Mountain, Phase II project (4.5 miles) was added to better control fires started by Bradley and helicopter gunneries and to compartmentalize the rocket pits, where numerous wild fires start each year. During the last 12 months, fires in this area impacted three MURs, resulting in 324 separate shutdowns and the loss of 231 hours of unit training time.

Adequate time is not available to complete Henson Mt, Phase II in one FY, due to required training and ranges down for construction of the digital MPRC. The project will be worked during Fall/Spring clean ups, when ranges and funds are available.

Annual maintenance of firebreaks is a mandatory requirement to prevent grasses from growing on firebreaks. Clean firebreaks have stopped fires from burning habitats with minimal fire fighting response and impact to training. The network must be maintained as Hood is again within the massive fire trend window. One additional measure can reduce wild fires on Hood.

Prescribed burning by DPW, during the first week in Jul and mid Dec, removes flammable fuel loads from around the trails and ranges, preventing fires from jumping into adjacent compartments inside the live fire training area.

SJA has determined that a maintained firebreak network meets requirements to keep the installation in compliance with USFWS.

TAB Q: SUBJECT: Oak Wilt Management

1. On 17 Mar 99, DPTM ITAM staff hosted a meeting with USDA-Natural Resource Conservation Service (NRCS) and Texas Forest Service (TFS) field staff. On 3 Apr 99, ITAM staff and NRCS discussed the issues with DR. Larry White, Texas Agriculture Extension, Range Specialist, Texas A&M University; DR. David Apple, Texas A&M, plant pathology; and Clint Cross, TFS.

3. Major issues discussed were:

- Concern of current juniper clearing operations could kill 90% of the oak trees on Fort Hood.

- Viability of hand clearing areas that have oak trees in the vegetation.

- Viability of painting wounds to oak trees damaged by mechanical juniper clearing.

4. The Fort Hood ecosystem is complex and oak wilt is only one of a myriad of concerns in the ecosystem chain of events that impact the installation. The primary issue is that juniper clearing procedures support the entire ecosystem (to include training).

5. Key comments from the 17 Mar and 3 Apr meetings with NRCS, TFS, and Texas A&M:

a. Juniper is a high water using plant. Dense stands severely reduce soil moisture and ground water and cause stress on the oaks, thereby increasing the chance of damage by insects and diseases.

b. Oak wilt is a disease caused by the fungus *Ophiostoma fagacearum).* The fungus is systemic, inhabiting the ability of the vascular system to move water and nutrients upward resulting in wilting of leaves, and ultimately death of the tree. A Texas Red Oak may die within 2 weeks of being infected.

c. The Texas Red Oak, locally known as Spanish Oak, is the primary carrier of the disease. A tree of this species, which dies in late summer or early fall will develop fungal mats. The mats consist of an orange, sticky, jell material, which attracts sap feeding insect vectors (primarily *Nitidulids* or very small picnic beetles). When the beetles travel from the fungal mats with fungi spores attached to their bodies (or in its digestive track) to a fresh wound on another Texas Red Oak or Live Oak, it <u>may</u> cause infestation of a healthy tree. Infestation must occur within 72 hours or before a tree wound dries. Trees of the White Oak family are not as likely to be infected, but if they are, they may take several years to die. Normally, they have more tolerance to oak wilt.

d. Approximately 1% of the spread of oak wilt can be attributed to insect vectors and 99% through the root systems. <u>The major method for the spread of the disease is through the root system</u>. Oak trees grow in colonies with their roots grafted together and provide the primary means of transportation for the disease. The disease normally moves at a rate of approximately 100 feet per year. Natural boundaries such as rock layers or open spaces between oak colonies can restrict wilt spread. If all above ground plant parts are removed the root system will continue to spread the disease. Usually about 90% of the trees in a wilt center will die.

   Painting of wounds is a method recommended in urban landscapes to prevent insect infestation. Wound painting of all oak trees is not a practical practice. This requirement would be applicable to all oak trees, regardless of size of trees or ability to find cut seedling roots. Currently the mechanical brush removal methodology on Fort Hood Training Lands does not treat (paint) wounds on damaged oaks, but does require contractors to minimize damage to oak trees. This is the common practice for brush removal on private lands.

e. Wilt threat does not significantly increase with current juniper clearing methods. Other vectors that can contribute to oak wilt spread are: tree limbs rubbing, wind, or animal damage.

g. The NRCS, TFS, and A & M believe that the total ecosystem benefits from juniper removal far outweigh potential damage by induced wilt from mechanical clearing.

h. Current oak wilt centers can regenerate if juniper is managed. Unmanaged juniper trends show it will replace hardwoods and other vegetation and become 100% juniper. Unmanaged endangered species habitats will eventually evolve to heavy populations of juniper, degrading its capabilities to support all species of wildlife.

i. Encroaching juniper reduces regeneration of hardwood and other plants utilized by deer. This is very evident in areas with dense canopies of juniper. Encroaching juniper increases stress and reduces the long-term survival of hardwoods. Managing juniper to more desirable densities through mechanical methods, hand clearing, and prescribed fire supports survival and regeneration and sustainment of hardwood and grasses.

j. Some Fort Hood endangered species habitats have active oak wilt infestation centers. These centers transmit the disease to other oak trees within habitat areas.

k. There is a continuing need to identify the extent of Fort Hood’s wilt problem and to develop a conservation management plan to control oak wilt. Such a plan must include current wilt on the installation.

6. An aggressive oak wilt management program is needed on Fort Hood to control wilt effects, but wilt will never be eliminated from the ecosystem (wind, red oaks, infected sites adjacent to Fort Hood). To expect any beneficial results, there must be proactive management practices. A recommended practice, ‘trenching’, appears to be an effective measure. Trench depth would be around 4-5 feet and be placed 100 feet outside of infected areas. Trenches sever root masses and are immediately refilled. This practice controls the spread of wilt to healthy trees. Cultural resources locations would have to be identified and integrated in planning trench emplacements. Such a system would be expensive and difficult to put in place.

7. Infestation/death rates at Hood require more study.

8. Texas A&M and TFS clearly have subject matter experts and appear to have an interest to work the Fort Hood oak wilt issue. Follow on meetings of all interested entities to discuss oak wilt management and the Fort Hood Ecosystem are needed.

UPDATE:
Oak wilt management is currently funded and a management plan is being developed and incorporated into the Endangered Species Management Plan.

TAB R: MESQUITE MANAGEMENT

Honey Mesquite *(Prosopis glandulosa)* is a prolific woody species whose increasing spread at Fort Hood is an area of concern. It is usually confined to deep clay and clay loam soils of bottomland and upland sites. It spreads from seed, which is eaten by domestic livestock and wildlife. The digestive tract of animals serve as a medium to scarify, or break down the protective seed coat, and the manure provides a good medium for germination of the seed. It will rapidly invade open areas and become very dense stands. A plant will mature in 3-5 years. An older plant may have taproots up to 40 feet deep and lateral roots up to 50 feet away from the main stem. The volume and distribution of roots makes it an efficient gatherer of soil moisture, and it is able to withdraw water from soil particles at much higher atmospheres moisture tension (atm) than can grasses and forbs. A crown bud directly below the soil surface sprouts profusely when the top is removed making it harder to control mechanically. Herbicides offer the best method of control. Mechanical control would require uprooting the bud zone. A mature plant has very woody, stiff thorns making it difficult to walk through dense stands. They are also damaging to tires of wheeled vehicles. As much as 60 million acres of Texas contain this plant in varying densities. One third of these acres have developed very dense stands due to the lack of natural fires and other control / management practices. Approximately 12,000 acres of Fort Hood training lands have this plant to some degree, and ½ of this acreage is becoming very dense, making it unsuitable for some types of training.

Control of Mesquite is best accomplished with herbicides. Aerial application offers the most feasible method. EPA approved herbicides today are very selective in the plants that they do and do not affect so desirable trees are not damaged. Application should be made 45 days after bud break to obtain optimum effect. Normal kill rate is 30-40% with 3 successive annual applications required for near 100% control. Prescribed fire after the third year and at 3-5 year intervals will help to clean dead materials and discourage seedling development.

Responsible and sound resource management dictates the management of invasive species, to include FORSCOM recognized species above those identified in the federal list, to balance the need to maintain and sustain lands on a military installation viable to support current training and future wheeled combat unit maneuver requirements, wildlife, and promote the safety of personnel and equipment conducting training.

TAB S: Erosion Management

Soil erosion is a serious threat to the viability of training lands to support unit readiness and Task Force training on most military installations, especially where heavy armor is present. Fort Hood is no exception. The fact that it has 3 active Division size units, separate supporting brigades, a National Guard Division and numerous Reserve units training here causes over-use of the training lands and very severe erosion.

There are three classes of erosion on Fort Hood;

(1) Sheet – removal of thin uniform layers of soil not evident by observation,

(2) Rill – removal of soil in amounts which causes numerous small channels up to a few inches in depth, and

(3) Gully – removal of large amounts of soil causing deep channels up to several feet in depth.

Soils have been identified in published booklets for both counties covering Fort Hood. Each soil series has a tolerance threshold (T value) assigned by the U. S. Department of Agriculture. This T value is the amount of loss a soil can withstand and still be capable of maintaining a vegetative cover or to maintain the desired production. This value ranges from 5-8 tons per acre per year (a ton of soil is approximately the thickness of a dime over an acre). An acre is 43,560 square feet or 208.7 feet square). The loss of soil above this threshold results in rill and gully formation. If unchecked it will result in training lands not being conducive to maneuver training, to where not all training standards can be met. Land Condition Trend surveys during the last 10 years have shown that some areas that maintain a good vegetative cover are only losing 1-3 tons per acre, while others exceed 250 tons per acre. The latter being in maneuver lanes containing a high percentage of bare soil from increased training activities, and on steep slopes having had concentrated traffic. Another area of severe erosion is the tank trail network where literally hundreds of tons of soils are being eroded.

The resulting sediment from the major training lands is transported by runoff water into streams and eventually into Belton Lake and beyond. This is very evident in

Belton Lake below the Curry Bridge with silt islands being created. A comparison of Ortho photography between 1995 and 1999 show that these silt islands grew more than 13 visible acres on the surface. Depending on the depth of the water, which is in excess of 20 feet, the volume of silt deposited in the lake is tremendous. Realizing that all of the sediment is not from Fort Hood, water quality monitoring stations (on incoming and outgoing points of Cowhouse Creek) does show that a majority of sediment is coming from the Fort Hood landscape.

The western training areas are the primary maneuver training areas on Fort Hood totaling approximately 67,000 acres. There are three primary maneuver lanes within the western training areas. These three lanes contain a total of 15,600 acres of documented gully networks (224 miles of gullies) that are 3 - 6 feet deep. These present a challenge not only to trainers, but also to land managers to design methods of repairing and maintaining the lands to support its intended training use. Much of it is accumulative damage over the last 50+ years. Land damage has accelerated during the last 20 years because of the greater number of vehicles conducting maneuver training, current vehicles are heavier and faster, causing greater damages and extensive bare soil, and inadequate land repair funding and command emphasis.

The severely eroded training lanes, described above, require very expensive corrective measures, to protect the land and improve training capabilities. A cooperative effort of ITAM and DPW is applying a series of practices to mitigate erosion in these areas. They are as follows:

- Coordinate efforts to defer training from area(s) for at least one and preferably 2 years while work is under way and to allow for as much natural recovery as possible.
- Cattle grazing deferment until the forage assessments indicate adequate forage available and area(s) are no longer being repaired (includes a viable re-vegetation growth period after seeding or prescribed burns).
- Construct stair step series of rock check dams in gullies to reduce channel cut erosion, contain sediment and provide maneuver access across gullies.

- Fracture (rip) the compacted soils to allow water and air into the soil, helping grass roots to penetrate into the soil profile.
- Seed desirable grass mixtures in areas where inadequate vegetative cover exists.

In moderately damaged and eroded lands lesser measures are required to repair and renovate them. These will require routine maintenance such as:

- Ensuring that units file a maneuver damage report and clean up and repair the landscape within the unit responsibility/capabilities
- Units properly recover (fill, smooth/shape) excavation sites after exercises
- Installation trail maintenance
- Installation vegetation maintenance
- Installation repair of damage resulting from training and identified on filed maneuver damage reports: trails, stream crossings, hillside access trails, erosions structures, and landscape (above unit capabilities)

MANAGE LAND AND RANGES

Yes/No/N/A

LAND AND RANGE MANAGEMENT

PURPOSE. This section contains the evaluation criteria and checklist(s) for assessment of the division/separate brigade Land and Range Management.

a. The following is provided for information and use as a guide in preparing for III Corps assessment of the division's and separate brigade proficiency with managing land and range assets.

b. Point of contact for this task is the G3 Training, III Corps, Building 1001, telephone number 287-6600/9676/2197.

RESPONSIBILITY. Unit commanders and activity directors/custodians are urged to use these standards as a management tool to ensure that units comply with land and range management procedures at all times, and enable them to conduct internal inspections as a part of the Command Inspection Program.

GENERAL. The inspection standards contained herein are applicable to Inspector General inspections, command inspections, and staff inspections.

STANDARD. A "no" on two or more of these questions would be evaluated as an unsatisfactory rating of program support for land and ranges management.

III CORPS LAND AND RANGES MANAGEMENT INSPECTION CHECKLIST

1. Does the unit have copies of monthly land usage reports on hand? (Ref: FH 350-40, page18-19)

2. Does unit maintain monthly joint usage reports on file? (Ref: FH 350-40, page11).

3. Have copies of usage reports been provided to Range Control Scheduling Office. (Ref: FH 350-40, page19)

4. Does unit maintain copies of all road closure requests on file - approved or disapproved? (Ref: FH 350-40, page 31)

5. Does unit have a current list of the ITAM Land and Range Maintenance Schedule? (Ref: FH 350-40, page 87)

6. Does the unit have a current copy of III Corps Endangered Species Survey Area schedule? (Ref: FH 350-40, page 88)

7. Does unit have a current copy of III Corps FY Gunnery Calendar (GSP)? (Ref: FH 350-40 page 14, FH 350-1, page 10)

8. Does unit have a current copy of the III Corps Long Range Training Calendar? (Ref:

FH 350-40, FH 350-1, page 10)

9. Does the unit have a current copy of range abbreviations and names? (Ref: FH 350-18, page E-1 to E-4)

10. Does unit have running log of all Land, Range, and Airspace requests submitted by subordinate units on hand? (Ref: FH 350-40, page 15-30)

11. Does unit have a map reference with a min. of training areas and land groups outlined on it? (Ref: FH 350-40, page 5, 16, 25)

12. Does unit schedule range and training area requirements during their priority period? (Ref: FH 350-40 page 10, GSP)

13. Does unit have a copy of current mandatory shutdown times on hand? (Ref: FH 350-40, page 47) (Pulled from Ft Hood Public Folder under Range File)

14. Does unit maintain land clearance documents for subordinate and joint-use land users? (Ref: FH 350-40 page 5, 19, 80-83)

15. Does unit approve and maintain excavation request documents for subordinate and joint-use land users? (Ref: FH 350-40 page 5 and 41, FH 420-2 page 30-31)

16. Does unit maintain the current Fort Hood Training Map, with environmental sensitive areas, in unit load plan and on vehicles? (Ref: FH350-40 page 89-90, FH 200-1 page 30)

17. Does unit turn in range data for safety approval and programming of ranges at least 30 days prior to the event? (Ref: FH 350-40 page 40)

18. Does unit have the current Out Area Program designations? (Ref: FH350-40 page 92)

19. Does unit plans depict out areas as non -maneuver areas? Does the unit assess casualty, battle damage, and decontamination actions on elements that go into the out areas? (Ref: FH350-40 page 92)

20. Does unit attend the monthly Installation Resource Conference? (Ref: FH 350-40 page 13)

This information is required to have on hand and filed. It is the responsibility of the unit Land and Range NCO to ensure that he/she has all this information on hand at all times.

UNIT: **DATE:**

TAB U: Prescribed Burn Program

Regional prescribed burning started in FY03, when grazing deferments expanded fine fuel loads. Prescribed burning is a rotational burning of large sectors to control young juniper and maintain training lands on a continuous basis. This program's primary intent is to manage juniper on the training landscape.

Coordination for burn areas will require deferments of sectors from grazing to ensure there is an adequate fine fuel load to carry the fire and an adequate growth recovery period.

Trainers will be informed of prescribed burn plans on an annual basis to include location and timeframes for burning.

TAB V: Scrap Metal and Target Residue Management

1. Numerous hard targets and range residue have accumulated on the live fire ranges. The EPA Munitions Rules detailed specific requirements to installations before any residue removal can occur. These requirements must be accomplished before scrap metal and target residue could be allowed to leave a range complex.

2. Several meetings were conducted with installation staff on residue disposal and required procedures. The results of the 24 Jun 04 meeting were the approved SOW and procedure objectives to safely resolve all aspects of the EPA Munitions Rules and allow for the certification, removal, disposal and recycle of the scrap metals and target residue from Fort Hood and deals with any UXO found in or around the residue.

3. The work objectives for the residue removal are:

- Remove all Range Targets, recyclable materials and range residue from the areas designated.
- Certify removed range targets as free from ammunition, explosives, or dangerous articles (AEDA) and recycle materials as appropriate.
- Certify range residues (Ordnance Related Scrap) as free from ammunition, explosives, or dangerous articles (AEDA) and recycle materials as appropriate.
- Process these materials for shipment and recycling and provide Certificates of Destruction for all materials removed from Fort Hood.
- Provide a Final Report after completion of field activities.

4. The SOW for the residue removal plan are:

- Mobilize, to Ft Hood, TX, all personnel and equipment necessary to remove 6 range targets and range residue previously designated by Ft Hood personnel at designated locations.

- Inspect, process, and remove all metallic recyclable material and dispose of these materials greater in size than 2’ x 2’ or 50lbs.

- Clear access routes and work areas prior to moving heavy equipment or vehicles into work areas. Live ordnance encountered will be relocated if “Acceptable to Move”.

- Destroy any live ordnance item found which may not be moved provided it impedes removal of existing targets or installation of new targets.

- All material will be thoroughly inspected by qualified UXO personnel for the presence of Ammunition, Explosives, and/or Dangerous Articles (AEDA) prior to handling and processing.

- No range residue will be removed from Ft Hood ranges without first being certified and verified by contractor as safe and/or inert.

- Any scrap removed from Ft Hood ranges will first be certified and verified as free from AEDA and Munitions and Explosives of Concern (MEC), and demilitarized in accordance with Defense Demilitarization Manual, DoD 4160.21-M-1. Transfers of material to recycling facilities will be documented using the DoD Form 1348-1A (if required) and EODT SOP 120G, which will contain the following certification:

  “This certifies that AEDA Residue, OE Scrap, and/or explosive contaminated property listed has been 100 percent properly inspected and to the best of our knowledge and belief are inert and/or free of explosives or related materials”

- All recyclable material will be transported to an approved scrap recycling facility for final disposal by shredding and/or smelting.

- Final destruction of all materials removed from Ft Hood ranges will be verified by certificates of destruction, which attest that all materials have been destroyed so as to be unrecognizable as military-related items.

- All government property recovered as recyclable material will be demilitarized in accordance with DOD 4160.21 M-1 if required.

- All work performed during this operation will comply with all applicable Safety and Environmental regulations.

5. Residue removal will be conducted upon availability of work sites without impacts to training and availability of funds.

TAB W: Virtual Training

1. Virtual training allows units to conduct realistic training without going to the field. This concept reduces training damages that occur when tracked vehicles maneuver across the landscape and allows units to train until commanders are satisfied with the conduct of the training.

2. ITAM furnishes CCTT the latest copies of the installation ortho-photography to allow units train as if they were actually in the field. This provides landscape realism, reduces computer gamesmanship, and enhances unit training while conserving training resources.

3. Virtual training allows units to maintain readiness standards, while other units are using the terrain.

TAB X: Sediment and Erosion Structure Management

1. The control of sediment is a priority to sustaining our training lands for our training mission. Fort Hood works to protect existing sediment retention measures to sustain training. Sediment movements disrupt the natural landscape, creating gullies, steep drop offs, cliffs, and effects downstream water quality and training capabilities.

2. Over the last several decades, large amounts of sediment moved from our landscape into the mouth of the Cowhouse Creek Arm that flows into Belton Lake. Water volume and quality may be impacted in the near future, placing training requirements squarely against the surrounding communities needs for water. To prevent this, Fort Hood must make plans with the Corps of Engineers to remove sediment from the Arm and restore Belton Lake’s water capacity. Plans and collection sites need to be determined and where to reposition the collected sediment once it is removed and dried from the Arm and the mouth of the Lake.

3. Fort Hood has constructed over 30 sediment retention ‘lakes’ erosion structures to keep additional sediment from moving into the Cowhouse Creek Arm and Belton Lake. Monitoring of these structures has forecasted the lifespan of the majority of structures to become unserviceable in 2012. Enhanced monitoring of structures was started in 2004 to define each structures remaining lifespan and to determine priority windows for Hood to remove sediment from these structures to extend their lifespan and reposition the sediment. Failure to plan and control the structures will eventually increase the sediment leaving the installation, potentially create water quality and quantity concerns for off post communities, and may impact the amount of training the regulators will allow us to conduct on post (vs sediment continually impacting Belton Lake). An additional concern is as the ‘lakes’ silt up, there is the potential to create wetlands and the host of training restrictions associated with them coming to Hood.

4. Fort Hood must manage sediment and erosion structures. MCA, CofE work, and Master plans must be emplaced before structure lifespan terminate.

APPENDIX B

Agency Correspondence

TETRA TECH, INC.
1960 Eagle Valley Court
Lawrenceville, GA 30043
Telephone (678) 377-7292
Fax (678) 442-7628
eric.dohner@tetratech-ffx.com

November 17, 2004

Thomas J. Cloud, Jr.
Field Supervisor, Ecological Services
U.S. Fish and Wildlife Service
711 Stadium Drive, Suite 252
Arlington, TX 76011

Dear Mr. Cloud:

Fort Hood, Texas is preparing a major revision of its 2000 Integrated Natural Resources Management Plan (INRMP) in accordance with the Sikes Act Improvement Act of 1997 and Army Regulation 200-1 (*Environmental Sustainability and Stewardship*). Concurrent to the development of the INRMP, Fort Hood will assess the need for, and if necessary prepare additional environmental analysis and documentation required to comply with the National Environmental Policy Act (NEPA) of 1969. In accordance with NEPA, the Endangered Species Act, and the Fish and Wildlife Coordination Acts, the Environmental Assessment will evaluate the known environmental impacts, both positive and negative, associated with implementing the proposed action, i.e., the INRMP. The INRMP and its associated NEPA documentation will be combined into a single report.

The purpose of this correspondence is to formally request a list of federal- and state-listed threatened, endangered and candidate species that are known to occur, or could potentially occur on, or in the vicinity of Fort Hood. It would also be useful to know whether there are any other sensitive natural resources or ecosystems that should be considered during the development of the INRMP. For quick reference, the installation can be found on the following 24,000 scale USGS quadrangle maps:

- Bland, TX
- Copperas Cove, TX
- Ding Dong, TX
- Fort Hood, TX
- Gatesville West, TX
- Killeen, TX
- Leon Junction, TX
- McMillan Mountains, TX
- Moffat, TX
- Nolanville, TX
- North Fort Hood, TX
- Pidcoke, TX
- Post Oak Mountain, TX
- Shell Mountains, TX
- Twin Mountains, TX
- Youngsport, TX

If you have any questions or need additional information I can be reached by phone at (678) 377-7292, by facsimile at (678) 442-7628, and by e-mail at eric.dohner@tetratech-ffx.com. I would like to thank you in advance for your assistance.

Sincerely,

Eric T. Dohner
Project Manager
Tetra Tech, Inc.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
WinSystems Center Building
711 Stadium Drive, Suite 252
Arlington, Texas 76011

December 15, 2004

Mr. Eric T. Dohner
Tetra Tech, Inc.
1960 Eagle Valley Court
Lawrenceville, Georgia 30043

Dear Mr. Dohner:

This responds to your November 17, 2004, letter requesting information on federally listed threatened and endangered species with regard to the Department of the Army's proposed revision of the Integrated Natural Resources Management Plan (INRMP) for Fort Hood Military Reservation in Bell and Coryell Counties, Texas.

Our records indicate that the following threatened (T), endangered (E), and candidate (C) species have been documented, or are known to occur in Bell and Coryell Counties:

black-capped vireo (*Vireo atricapilla*) - E, Bell, Coryell
golden-cheeked warbler (*Dendroica chrysoparia*) - E, Bell, Coryell
whooping crane (*Grus americana*) - E, Bell, Coryell
bald eagle (*Haliaeetus leucocephalus*) - T, Bell
Salado salamander (*Eurycea chisholmensis*) - C, Bell
smalleye shiner (*Notropis buccula*) - C, Bell

There is no designated critical habitat for listed species in Bell or Coryell County. Candidate species are not afforded federal protection under the Endangered Species Act; however, we recommend that potential impacts to these species be considered during project planning. For information on the general biology of these species, visit our website at http://arlingtontexas.fws.gov.

As you may know, the Service is currently conducting consultation under section 7 of the Endangered Species Act with the Army regarding military and other activities at Fort Hood. The Biological Assessment submitted by the Army as part of the consultation contains the most current information on federally listed species known to occur at Fort Hood. We recommend it be used for information related to the INRMP until the consultation is completed.

Thank you for the opportunity to provide information on the proposed project. If you have any questions, please contact Omar Bocanegra of my staff at (817) 277-1100.

Sincerely,

Tom Cloud

Thomas J. Cloud, Jr.
Field Supervisor

CC: Commander U.S. Army Garrison, Bldg 1001, W321, Fort Hood, TX.

TETRA TECH, INC.
1960 Eagle Valley Court
Lawrenceville, GA 30043
Telephone (678) 377-7292
Fax (678) 442-7628
eric.dohner@tetratech-ffx.com

November 17, 2004

Kathy Boydston
Texas Parks and Wildlife Department
4200 Smith School Board Road
Austin, TX 78744

Dear Ms. Boydston:

Fort Hood, Texas is preparing a major revision of its 2000 Integrated Natural Resources Management Plan (INRMP) in accordance with the Sikes Act Improvement Act of 1997 and Army Regulation 200-1 (*Environmental Sustainability and Stewardship*). Concurrent to the development of the INRMP, Fort Hood will assess the need for, and if necessary prepare additional environmental analysis and documentation required to comply with the National Environmental Policy Act (NEPA) of 1969. In accordance with NEPA, the Endangered Species Act, and the Fish and Wildlife Coordination Acts, the Environmental Assessment will evaluate the known environmental impacts, both positive and negative, associated with implementing the proposed action, i.e., the INRMP. The INRMP and its associated NEPA documentation will be combined into a single report.

The purpose of this correspondence is to formally request a list of federal- and state-listed threatened, endangered and candidate species that are known to occur, or could potentially occur on, or in the vicinity of Fort Hood. It would also be useful to know whether there are any other sensitive natural resources or ecosystems that should be considered during the development of the INRMP. For quick reference, the installation can be found on the following USGS quadrangle maps:

- Bland, TX
- Copperas Cove, TX
- Ding Dong, TX
- Fort Hood, TX
- Gatesville West, TX
- Killeen, TX
- Leon Junction, TX
- McMillan Mountains, TX
- Moffat, TX
- Nolanville, TX
- North Fort Hood, TX
- Pidcoke, TX
- Post Oak Mountain, TX
- Shell Mountains, TX
- Twin Mountains, TX
- Youngsport, TX

If you have any questions or need additional information I can be reached by phone at (678) 377-7292, by facsimile at (678) 442-7628, and by e-mail at eric.dohner@tetratech-ffx.com. I would like to thank you in advance for your assistance.

Sincerely,

Eric T. Dohner
Project Manager
Tetra Tech, Inc.

TEXAS PARKS & WILDLIFE

December 7, 2004

Eric T. Dohner, Project Manager
Tetra Tech
1960 Eagle Valley Court
Lawrenceville, CA 30043

RE: Revision of the 2000 Integrated Natural Resource Management Plan for Fort Hood, Threatened and Endangered Species Information, Bell County

Dear Mr. Dohner:

Texas Parks and Wildlife Department received your letter dated November 17, 2004 notifying us of the revision of the 2000 Integrated Natural Resource Management Plan (INRMP) for Fort Hood. Your letter specifically requested information on threatened or endangered species that could occur within the vicinity of Fort Hood. That information is provided as well as information on other sensitive natural resources that should be considered in the INRMP.

The information attached is listed species information and information on other sensitive resources for the list of USGS quadrangle maps that you provided. The county lists can be reproduced but the Department requests that you do not publish any of the occurrence records in the INRMP. There is a bald eagle nest (*Haliaeetus leucocephalus*) that has been documented on the Lampasas River and its territory extends into Fort Hood. It would be extremely beneficial if you would share any information you might have on the bald eagle or other species (such as the Black-capped Vireo (*Vireo atricapillus*) or Golden-cheeked Warbler (*Dendroica chrysoparia*)) that occur within Fort Hood to allow us to update our Natural Diversity Database.

The Texas Parks and Wildlife Department's Land and Water Resources Conservation and Recreation Plan (LWRCRP) establishes priority habitat types and ecoregions based on the conserved status, threat and biological value. Every ecosystem in Texas is home to important game species, threatened and endangered species, significant habitats and communities. The Priority Ecoregion Analysis showed that native prairies, grasslands, and riparian habitats across the state are the most important wildlife habitats, contain the highest numbers of rare species, and are often the most threatened. These habitat types are listed as the highest priority to be conserved by TPWD. Riparian habitats and corridors in

4200 SMITH SCHOOL ROAD
AUSTIN, TEXAS 78744-3291
512-389-4800

www.tpwd.state.tx.us

urban areas are of extreme interest to TPWD as they are the most threatened subset of riparian habitat and are often the only wildlife habitat left. The INRMP should discuss these habitats and the potential for future operations to impact these habitat types, as well as those habitats listed in the occurrence records provided that occur within the boundaries of Fort Hood.

If you have any questions regarding the listed species information, please contact Celeste Brancel at 512-912-7021. Please direct any questions regarding the INRMP to me, including the draft document. If you have any questions regarding our comments, please do not hesitate to contact me at 512 -389-4638.

Sincerely,

Kathy Boydston

Kathy Boydston, Program Coordinator
Wildlife Habitat Assessment Program
Wildlife Division

KB:sm.10802

Attachment

APPENDIX C

Finding of No Significant Impact (FNSI)

DRAFT
FINDING OF NO SIGNIFICANT IMPACT
FOR IMPLEMENTING AN INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN
FOR FORT HOOD, TEXAS

Pursuant to the Council on Environmental Quality (CEQ) Regulations (40 *CFR* Parts 1500-1508) for implementing the procedural provisions of the National Environmental Policy Act (NEPA) (42 U.S.C. 4321 et seq.) and 32 CFR Part 651(*Environmental Analysis of Army Actions*), Fort Hood has conducted an Environmental Assessment (EA) of the potential effects associated with implementing an Integrated Natural Resources Management Plan (INRMP). Fort Hood has prepared this INRMP in accordance with the provisions of the Sikes Act (16 U.S.C. 670a et seq.) and Army Regulation 200-3 (*Natural Resources***C***Land, Forest, and Wildlife Management*).

Proposed Action. Fort Hood proposes to implement an INRMP for Fort Hood, Texas. The purpose of the proposed action is to carry out the set of resource-specific management measures developed in the INRMP, which would enable Fort Hood to effectively manage the use and condition of natural resources located on the installation. Implementation of the proposed action would support the Army's continuing need to train soldiers in a realistic natural setting while meeting other mission and community support requirements, practicing sound resource stewardship and complying with environmental policies and regulations.

The proposed action supports an ecosystem approach and includes natural resource management measures to be undertaken on Fort Hood, Texas. The proposed action focuses on a 5-year planning period, which is consistent with the time frame for the management measures described in the INRMP. This planning period would begin in Fiscal Year (FY) 2006 and end in FY 2010. Additional environmental analyses may be required as new management measures are developed over the long-term (i.e., beyond 5 years).

Alternatives. The development of proposed management measures for the INRMP included a screening analysis of resource-specific alternatives. The screening analysis involved the use of accepted criteria, standards, and guidelines, when available, and best professional judgment, to identify management practices for achieving Fort Hood=s natural resource management objectives. The outcome of the screening analysis led to the development of the proposed action as described above. Consistent with the intent of NEPA, this screening process focused on identifying a range of reasonable resource-specific management alternatives and, from that, developing a plan that could be implemented, as a whole, in the foreseeable future. Management alternatives deemed to be infeasible were not analyzed further. As a result of the screening process, the EA, made an integral part of the INRMP, formally addresses two alternatives, the proposed action (i.e., implementation of the INRMP) and the no action alternative.

Implementation of the no action alternative means that the proposed management measures set forth in the INRMP would not be implemented. Current management measures for natural resources would remain in effect, and existing conditions would continue. This document refers to the continuation of existing (i.e., baseline) conditions of the affected environment, without implementation of the proposed action, as the no action alternative. Inclusion of a no action alternative is prescribed by CEQ regulations and serves as a benchmark against which the proposed action could be evaluated.

Factors Considered in Determining that No Environmental Impact Statement is Required. The EA, which is incorporated by reference into this Finding of No Significant Impact (FNSI), examines potential effects of the proposed action and the no action alternative on resources and areas of environmental concern that could be affected by implementing the INRMP. These include air quality, noise, topography, geology, soils, water resources, wetlands, aquatic habitat, riparian habitat, terrestrial ecosystems, fauna, endangered, threatened, and rare species, cultural resources, land use, facilities, hazardous and toxic materials, socioeconomic resources, and environmental justice. Implementation of the proposed action would result in short- and long-term beneficial effects on identified resources and areas of environmental concern.

Findings. Based on the results of the EA, it is determined that implementation of the proposed action would have no significant direct, indirect or cumulative impacts on the quality of the natural or human environment. Implementation of the INRMP would be expected to improve existing conditions at Fort Hood, as shown by the potential for beneficial effects. The proposed action would enable Fort Hood over time to achieve its goal of maintaining ecosystem viability and ensuring sustainability of desired military training area conditions. Because there would be no significant environmental impacts resulting from implementation of the proposed action, an Environmental Impact Statement is not required and will not be prepared.

Comments on the INRMP and this FNSI by any interested party may be submitted to John Cornelius, DPW-ENV, 4612 Engineer Drive, Room 76 Fort Hood, TX 76544-5028. The deadline for receipt of comments is 30 days from publication of the Notice of Availability (NOA). The INRMP/EA will be made available for public review at the Killeen Public Library, 205 East Church Avenue, Killeen, Texas; the Temple Public Library, 100 West Adams Avenue, Temple, Texas; the Copperas Cove Public Library, 501 South Main Street, Copperas Cove, Texas; the Gatesville Public Library, 111 North 8th Street, Gatesville, Texas; and at the Fort Hood Environmental Management Office, located at the Directorate of Public Works (DPW), Environmental Management Branch, Bldg 4219, 77th and Warehouse Avenue, Fort Hood, Texas. The INRMP/EA will also be available online at the Fort Hood DPW Public Notice Web site: http://www.dpw.hood.army.mil/HTML/PPD/Pnotice.htm.

Date: ________________________________ ____________________________________

Victoria Bruzese
Colonel, EN
Garrison Commander
III Corps and Fort Hood
Fort Hood, Texas

APPENDIX D

Soils on Fort Hood

APPENDIX D
GEOLOGY AND SOILS BACKGROUND INFORMATION

D1 TOPOGRAPHY

The topography at Fort Hood is defined by rolling prairies and steep breaks (Fort Hood, 2001b). Fort Hood is located northwest of the Balcones Fault Zone, a region of many small faults. Over geologic time the area surrounding this fault zone, including Fort Hood, has elevated as much as 500 feet in certain areas. The subsequent erosion of these areas has created an irregular and steeply sloping terrain (USACE, 2003).

Elevations range from 561 feet above sea level (asl) near the shores of Belton Lake in the Northeast Region, to 1,231feet asl in the Seven Mile Mountain area in the South Region of the installation. Slopes generally range from level in the floodplains of Cowhouse Creek to as much as 33 percent on tributary valley walls (USGS, 1990). The average slope of the installation is between 5 and 8 percent. The area north of Highway 190 generally slopes east, while the area south of Highway 190 generally slopes south and east (Fort Hood, 2001b). Figure 2-3 shows the topographic relief on Fort Hood.

D2 GEOLOGY

General Geology

The Fort Hood region is characterized as "hill and lake country," with topographic features and landforms characterized by valleys, buttes, and mesas. Fort Hood is located near the southeastern edge of the Mid-Continent Plains and Escarpments physiographic region, and near the eastern edge of the Edwards Plateau region (USACE, 2003).

This area was originally a rolling prairie underlain by limestone beds, but softer limestone has slowly eroded away, leaving long narrow valleys and streams flowing in a generally southeastern direction separated by ridges of harder limestone (Fort Hood, 2001b). The dissolution of the remaining limestone has formed the karst topographic features (caves, sinkholes, underground springs) that are found throughout the region (Reddell and Veni, 2004). Karst features are primarily found in the Northeast Region of Fort Hood near Belton Lake. Figure 2-3 shows the karst features on Fort Hood.

Geologic Formations

Several geologic formations from the Cretaceous and the younger Quaternary Ages can be found on Fort Hood. These formations are, from oldest to youngest, the Glen Rose, Paluxy Sand, Walnut Clay, Comanche Peak Limestone, Edwards Limestone, Kiamichi Clay, Duck Creek Limestone, Fort Worth Limestone, and Denton Clay formations. In general, these formations are comprised of limestone, sandstone, calcareous clay, shale, sand, and/or sandy marl (USACE, 2003). All Cretaceous strata cropping out on Fort Hood strike generally in a north-northeasterly direction, and dip in an east-southeasterly direction. The Glen Rose Formation is a major outcrop in the southern portion of Fort Hood, and due to its composition and differential erosion, exhibits a typical terraced or 'stair step' configuration (Fort Hood, 2001b). Formations from the Quaternary Age can be found near Leon River, Cowhouse Creek, and their tributaries. These formations are Pleistocene terrace remnants and Holocene flood plain sediments. These formations are comprised of gravel, sand, silt and clay size sediment eroded from upstream uplands (USACE, 2003).

Seismicity

Small seismic events with magnitude less than 4.0 have occurred in the region surrounding Fort Hood. Minor earthquakes were recorded in the region in 1891 and 1932. Nineteen other minor earthquakes have been recorded in the region since 1981. The largest of these earthquakes was recorded in 1993 with a magnitude of 4.3 (USGS, 2005).

D3 PETROLEUM AND MINERALS

There is no petroleum production on Fort Hood. Topsoil, sand, gravel, and road base materials are the only known mineral resources that occur within the Fort Hood installation (USACE, 2003). These minerals are of limited quantities and quality (Fort Hood, 2001b).

D4 SOILS

There are 40 unique soil series found on Fort Hood (USDA, 1977; 1985). The most abundant soil series are shown on Figure 3.8-1. The six predominate soil series include Topsey Clay Loam, Doss-Real Complex, Eckrant-Rock Outcrop Complex, Real-Rock Outcrop Complex, Nuff Very Stony Silty Clay Loam, and Evant SiC. These soils account for 154,640 acres, or 77 percent of Fort Hood. In general the soils of Fort Hood are well drained and moderately permeable, but can vary widely in other characteristics such as depth, parent material, and slope. Table 3.8-1 lists the names of each soil series found on Fort Hood, including the acreage, prime farmland and erodibility classification, drainage, landscape position, and parent material.

Many of the soils on Fort Hood are naturally susceptible to soil erosion. Soils categorized as highly erodible cover approximately 25,700 acres, or 13 percent of the installation, and soils categorized as potentially highly erodible cover approximately 164,600 acres, or 75 percent of the installation. The remainder of the soils on the installation are not highly erodible. As a result of the soil erodibility and land use activities, gullies have formed in many areas of the installation (NRCS, 2005). The locations of highly erodible soils, potentially highly erodible soils, and recorded gullies are shown on Figure 2-4.

Five soils that occur on Fort Hood are considered to be hydric soils (USDA-NRCS, August 2005). These soils cover approximately 5,453 acres, or 2.5% of the installation, and are generally located along the stream banks of Cowhouse Creek, Nolan Creek, and Leon Creek and their tributaries (USDA-NRCS, 2005). The hydric soils are generally located along the stream banks of Cowhouse Creek, Nolan Creek, and Leon Creek and their tributaries. Twenty soils that occur on Fort Hood are considered to be prime farmland soils. These soils cover approximately 41,800 acres, or 19 percent of the installation. The prime farmland soils are generally located near the main cantonment area, West Fort Hood (WFH), North Fort Hood (NFH), and along floodplains (NRCS, 2005). Portions of Fort Hood are used for grazing activities. Currently, no land on Fort Hood is used for growing crops (USACE, 2003).

Table D-1
Soils on Fort Hood

Soil Series Name	Acres	Prime Farmland	Erodibility	Drainage	Landscape Position	Parent Material
Topsey CL, 3 To 8 % Slopes Severely Eroded	40,113	No	PHE	well drained	gently sloping to moderately sloping sideslopes	surface: CL subsoil: Si (upper) shaley SiCL (lower)
Doss-Real Complex, 1 To 8 %	33,477	No	PHE	well drained	gently sloping to steeply sloping uplands	surface: gravelly SiC subsoil: gravelly C
Eckrant-Rock Outcrop Complex, 1 To 5 % Slopes	26,374	No	PHE	well drained	undulating to very steep uplands	surface: very gravelly C subsoil: limestone
Real-Rock Outcrop Complex, 12 To 40 % Slopes	22,294	No	HE	well drained	gently sloping to steeply sloping uplands	surface: gravelly CL subsoil: extremely gravelly CL (upper) cemented caliche (lower)
Nuff Very Stony SiCL, 2 To 6 % Slopes	19,359	No	PHE	well drained	gently sloping to moderately sloping uplands	surface: SiCL subsoil: SiCL (upper) Marly shaley SiL (lower)
Evant SiC, 1 To 3 % Slopes	12,756	No	PHE	well drained	gently sloping uplands	surface: SiC subsoil: C
Krum SiC, 1 To 3 % Slopes	10,763	Yes	PHE	well drained	moderately sloping uplands	surface: SiC subsoil: SiC
Slidell SiC, 0 To 2% Slopes	6,653	Yes	NHE	moderately well drained	nearly level to gently sloping uplands	surface: C subsoil: C
Denton SiC, 1 To 3 % Slopes	5,701	Yes	PHE	well drained	upland	surface: SiC subsoil: SiCL
Eckrant Cobbly SiC, 1 To 5 % Slopes	5,699	No	PHE	well drained	undulating to very steep uplands	surface: very gravelly C subsoil: cobbly C
Cho Clay L 1 To 3 % Slopes	4,675	No	PHE	well drained	nearly level to moderately sloping stream terraces and alluvial fans	surface: L subsoil: L
Bosque CL, 0 To 1 % Slopes, Occasionally Flooded	4,166	Yes	NHE	well drained	nearly level flood plain	surface: L subsoil: CL
Lewisville CL, 1 To 3 % Slopes	3,627	Yes	PHE	well drained	nearly level to srongly sloping stream terraces	surface: SiC subsoil: SiC
Topsey-Pidcoke Association 2 To 8 % Slopes	3,613	No	PHE	well drained	gently sloping to moderately sloping sideslopes	surface: CL subsoil: gravelly CL (upper) shaley SiCL (lower)

Table D-1
Soils on Fort Hood (continued)

Soil Series Name	Acres	Prime Farmland	Erodibility	Drainage	Landscape Position	Parent Material
Slidell SiC, 1 To 3 % Slopes	2,873	Yes	NHE	moderately well drained	nearly level to gently sloping uplands	surface: C subsoil: C
Bosque CL, 0 To 1 % Slopes, Rarely Flooded	2,788	Yes	NHE	well drained	bottomlands	surface: L subsoil: CL
Tarrant-Purves Association, 5 To 10 % Slopes	1,885	No	HE	well drained	moderately sloping to steeply sloping uplands	surface: cobbely C subsoil: limestone
Georgetown CL, 0 To 2 % Slopes	1,682	Yes	PHE	well drained	nearly level to gently sloping uplands	surface: CL subsoil: cobbly clay (upper) limestone (lower)
Seawillow CL, 3 To 5 %	1,663	No	PHE	well drained	gently sloping stream terraces	surface: CL subsoil: CL
Cisco FSL, 1 To 5 % Slopes, Moderately Eroded	1,545	No	PHE	well drained	upland	surface: FSL subsoil: SCL (upper) FSL (lower)
Bastsil FSL, 1 To 3 % Slopes	980	Yes	NHE	well drained	gently sloping terraces	surface: FSL subsoil: SCL
Purves SiC, 1 To 4 % Slopes	819	No	HE	well drained	gently sloping to moderately sloping uplands	surface: C subsoil: very gravelly C
Minwells FSL, 1 To 3 % Slopes	735	Yes	NHE	well drained	stream terraces	surface: FSL subsoil: CL (upper) gravelly S
Frio SiC, 0 To 1 % Slopes, Occasionally Flooded	677	Yes	NHE	well drained	nearly level bottomlands	surface: SiCL subsoil: CL (upper) SiC (lower)
Topsey CL, 3 To 8 % Slopes,	593	No	PHE	well drained	gently sloping to moderately sloping sideslopes	surface: CL subsoil: shaley SiCL
Crawford SiC, 1 To 3 % Slopes	521	Yes	PHE	well drained	nearly level to gently sloping uplands	surface: SiC subsoil: SiC
Water	473	No	-	-	-	-
Brackett Association, 8 To 12 % Slopes	403	No	HE	well drained	gently sloping to steeply sloping uplands	surface: gravelly CL subsoil: gravelly CL
Bosque CL, 0 To 1 % Slopes, Frequently Flooded	372	No	NHE	well drained	nearly level flood plain	surface: L subsoil: CL

Table D-1
Soils on Fort Hood (continued)

Soil Series Name	Acres	Prime Farmland	Erodibility	Drainage	Landscape Position	Parent Material
Lewisville SiC, 1 To 3 % Slopes	343	Yes	NHE	well drained	nearly level to moderately sloping uplands	surface: SiC subsoil: SiC
Wise CL, 3 To 5 % Slopes, Moderately Eroded	255	No	HE	well drained	uplands	surface: CL subsoil: SiL
Quarry, 1 To 40 % Slopes	243	No	-	-	-	-
Frio SiC, 0 To 1 % Slopes, Frequently Flooded	238	No	NHE	well drained	bottomlands	surface: SiCL subsoil: CL (upper) SiC (lower)
Bolar Gravelly CL, 1 To 4 % Slopes	799	Yes	PHE	well drained	steep uplands	surface: CL subsoil: CL
Speck Soils, 1 To 3 % Slopes	80	No	HE	well drained	nearly level to sloping uplands	surface: CL subsoil: C (upper) limestone (lower)
Lewisville SiC, 3 To 5 % Slopes	43	Yes	PHE	well drained	uplands	surface: SiC subsoil: SiC
Gravel Pits, 1 To 40 % Slopes	41	-	-	-	-	-
Dams	25	-	-	-	-	-
San Saba C, 1 To 3 % Slopes	19	Yes	PHE	moderately well drained	nearly level to gently sloping uplands	surface: C subsoil: C (upper) limestone (lower)
Venus CL, 3 to 5 % Slopes	15	Yes	PHE	well drained	nearly level to moderately sloping soils mainly on stream terrace and valley fill positions	surface: L subsoil: FSL

Note:
HE = Highly Erodible
PHE = Potentially Highly Erodible
NHE = Not Highly Erodible
C = Clay
L = Loam
Si = Silt
CL = Clay Loam
SiC = Silty Clay
SiCL = Silty Clay Loam
SiL = Silty Loam
LFS = Loamy Fine Sand
FSL = Fine Sandy Loam
SCL = Sandy Clay Loam

Sources: USDA, 1977; 1985; USDA-NRCS, 2005.

APPENDIX E

Endangered Species Management Plan (ESMP)

Headquarters
III Corps
& Fort Hood

Army Corps
US Of Engineers
Engineer Research and
Development Center

ERDC Technical Report DRAFT

Endangered Species Management Plan for Fort Hood, Texas; FY06-10

by
John D. Cornelius
Timothy J. Hayden
Patrick A. Guertin

Fort Hood Military Reservation is an 87,890 ha U.S. Army installation located in central Texas. Fort Hood is one of the Army's premier installations, providing training facilities for the full range of mission requirements including maneuver exercises for units up to brigade level, firing of live weapons, and aviation training.

The presence of Federally listed endangered species on Fort Hood is a significant natural resource management challenge for the Army and Fort Hood. In accordance with the Endangered Species Act of 1973, as amended, the Army must assist recovery of all listed threatened and endangered (T&E) species and their habitats under the installation's management authority.

Army Regulation (AR) 200-3 requires installations to prepare an Endangered Species Management Plan (ESMP) for all listed and proposed T&E species. The installation ESMP should be used as a tool to achieve conservation objectives for populations of listed and proposed T&E species and to minimize impacts on the training mission. AR 200-3 further encourages, but does not require, the development of ESMPs for all candidate species, and recommends that an integrated ESMP covering all T&E species be prepared if more than one such species occurs on an installation. The U.S. Fish and Wildlife Service Biological Opinion for Fort Hood (March 2005) provides requirements and guidance for endangered species management on Fort Hood.

This ESMP is written specifically for use by natural resource managers and leaders of training operations on Fort Hood to accomplish military training objectives while meeting conservation objectives for T&E species.

The objective of this ESMP is to provide a comprehensive plan for maintaining and enhancing populations and habitats of Federally listed and species of concern on Fort Hood while maintaining mission readiness in a manner consistent with Army and Federal environmental regulations

SF 298

(Report documentation page)

Foreword

This Endangered Species Management Plan was provided to Headquarters, III Corps and Fort Hood, TX, under Military Interdepartmental Purchase Request (MIPR). The Fort Hood technical monitor was John D. Cornelius, AFZF-PW-ENV-NR.

Several individuals and organizations assisted in preparation of this ESMP, and their contributions are gratefully acknowledged. Several individuals were responsible for collecting information and field data incorporated in preparation of this plan including David Cimprich, Rebecca Peek, Charles Pekins, Gil Eckrich and Timothy Marston. The Natural Resources Branch at Fort Hood assisted in all aspects of preparation of this ESMP. Personnel from the U.S. Fish and Wildlife Service, Texas Parks and Wildlife Department, The Nature Conservancy, and the Army provided data on distribution and abundance of T&E species on and around Fort Hood.

This work was performed by the U.S. Army Corps of Engineers, Engineer Research and Development Center, Construction Engineering Research Laboratory.

Contents

List of Figures

1. Introduction

Background

Fort Hood Military Reservation is an 87,890 ha (217,180 acres) U.S. Army installation located in central Texas. Fort Hood provides resources and training facilities for active and reserve units in support of the Army's mission. This mission is to maintain a total force, trained and ready to fight, to serve our nation's interests both domestically and abroad, and to maintain a strategic force capable of decisive victory. Fort Hood is one of the Army's premier installations in support of this mission. The full range of mission-related training activities are conducted on Fort Hood including maneuver exercises for units up to brigade level, firing of live weapons, and aviation training.

In addition to these activities, the Army allows a number of other non-military uses of the land on Fort Hood, including fishing, hunting, grazing, and other types of recreational activities. These uses, together with military training, affect the soil, water, vegetation and animals that occur on the installation.

The presence of federally listed endangered species on Fort Hood (Table 1) is a significant natural resource management challenge for the Army and Fort Hood. In accordance with the Endangered Species Act of 1973, as amended, the Army must assist in recovery of all listed threatened and endangered (T&E) species and their habitats under the Army's land management authority.

Army Regulation (AR) 200-3 requires installations to prepare an Endangered Species Management Plan (ESMP) for all listed and proposed T&E species. The installation ESMP should be used as a tool to achieve conservation objectives for populations of listed and proposed T&E species and to minimize impacts on the training mission. AR 200-3 further encourages, but does not require, the development of ESMPs for all candidate species and species of concern. AR 200-3recommends that installations prepare an integrated ESMP covering all T&E species if more than one such species occurs on an installation. The U.S. Fish and Wildlife Service Biological Opinion for Fort Hood (16 March 2005; Appendix A) provides terms and conditions for endangered species management on Fort Hood.

The greatest T&E species challenge on Fort Hood is management of significant breeding populations of two endangered avian species: the black-capped vireo (*Vireo atricapilla*) and golden-cheeked warbler (*Dendroica chrysoparia*). U. S. Fish and Wildlife Service (USFWS) recovery team meetings have recognized that populations on Fort Hood are important for range-wide recovery of these two species. In addition to these species, Fort Hood provides habitat for a variety of endemic cave-restricted fauna, potential transient occurrences of listed species and other species of concern (Table 1).

To ensure that the full range of military training can be effectively accomplished on Fort Hood, the Army has developed this comprehensive, integrated ESMP for management of endangered species on Fort Hood. Despite military training activities on Fort Hood, the installation presents a much less hostile environment for endangered species than most of the surrounding landscape, which is dominated by ranching, intensive agriculture, and rapid urban development. Through implementation of this ESMP, Fort Hood is in a vital and unique position to help conserve and recover listed species.

This ESMP is written specifically for use by natural resource managers and leaders of training operations on Fort Hood to accomplish military training objectives while meeting conservation objectives for federally listed species and species of concern. Implementation of this ESMP will also assist USFWS in achieving recovery objectives for these species and will provide a guide for natural resource personnel at other military installations facing similar endangered or sensitive species management and land use requirements.

Objective

The objective of this ESMP is to provide a comprehensive plan for maintaining and enhancing populations and habitats of federally listed and species of concern on Fort Hood while maintaining mission readiness in a manner consistent with Army and Federal environmental regulations.

Approach

Development of this ESMP is based on the concept of adaptive management. Adaptive management is founded on the idea that management of renewable natural resources involves a continual learning process (Walters 1986). This concept is a key guiding principle in the Department of Defense's ecosystem management policy (S. Goodman memorandum, 8 Aug 1994) and is promoted as an effective approach to successful T&E species recovery.

An adaptive management approach recognizes that protection and management actions are often implemented, by necessity, with imperfect knowledge. Recognition of this uncertainty allows development of monitoring and research approaches to progressively improve knowledge, and thus enhance decision-making and management capabilities.

This ESMP is based on the premise that protection, management, inventory, monitoring, and research are necessary components of an integrated, adaptive management approach for endangered species on Fort Hood. In this ESMP, objectives, justifications, and actions are developed and implemented under a framework that is mutually supportive of these components.

Fort Hood is in the fortunate position of being able to draw on several years of natural resource and endangered species inventory, monitoring, and research data in developing this ESMP. The endangered species research and monitoring programs implemented by

Fort Hood since 1987 are regarded by the environmental and scientific community as among the most comprehensive and credible sources of information available for the endangered golden-cheeked warbler and black-capped vireo. Information for this ESMP was gathered from installation project status reports, from related published reports, reports from cave research, and other published and unpublished documents. Personnel from the U.S. Fish and Wildlife Service, Texas Parks and Wildlife Department, The Nature Conservancy, and the Army provided data on distribution and abundance of endangered species on and around Fort Hood.

Even with this wealth of available knowledge, this ESMP recognizes the current state of knowledge is incomplete in many cases and further reinforces the adaptive management concept as a necessary and continual learning process for management of endangered species and species of concern on Fort Hood. AR 200-3 provides the mechanism for incorporating new information and approaches by requiring annual reviews and major revision of this ESMP every five years.

Mode of Technology Transfer

This ESMP is written to meet requirements of AR 200-3, the 16 March 2005 USFWS Biological Opinion for Fort Hood, and the ESA. It will be distributed to military and natural resource managers at Fort Hood, U.S. Army IMA, Headquarters Department of Army (HQDA) and to state and federal resource management agencies.

This plan will be reviewed annually and updated as required to meet conservation goals and Army mission requirements. This ESMP will be incorporated by inclusion or by reference into the installation Integrated Natural Resources Management Plan (INRMP). Once every five years, the INRMP, including the ESMP section, must undergo major revision to all parts (AR 200-3, 9-4).

2. Site Description and Land Use Activities

Mission and History

Fort Hood Military Reservation encompasses 87,890 ha (217,703 ac) located in central Texas in Bell and Coryell Counties adjacent to the city of Killeen. Fort Hood lies at the northern extent of the Edward's Plateau between the cities of Waco, 64 km (40 mi) to the northeast and Austin, 97 km (60 mi) to the south.

Fort Hood dates to 1942 when the Army established Camp Hood to prepare soldiers for tank destroyer combat during World War II. Renamed Fort Hood, it became a permanent installation in 1950. Various armored divisions have been assigned to Fort Hood since 1946.

Fort Hood is the only installation currently assigned two divisions. The installation provides the infrastructure and training lands for the 1st Cavalry Division and the 4th Infantry Division (Mech), III Corps Headquarters and its combat aviation assets, combat support, and combat service support units. With increased emphasis on force structure changes and Base Realignment and Closure (BRAC) initiatives, Fort Hood will likely remain the largest active U.S. installation in terms of assigned personnel. Total assigned personnel authorization is approximately 50,000 soldiers.

Fort Hood provides state-of-the-art facilities to support the full spectrum of training requirements of today's modern armed forces. Installation lands and ranges provide excellent training opportunities for mechanized maneuver and small unit exercises, combined arms training, and live-fire training.

Terrain

Fort Hood lies entirely within the Lampasas Cutplains physiographic region and is within the Grand Prairies Land Resource Zone. The forces creating the Balcones Fault Zone, just east of the installation, have uplifted underlying rock formations as much as 152 m (498 ft). Weathering and erosion over the past two million years has produced the present "cutplains" landscape characterized by the stair-step topography of a dissected remnant plateau. Numerous steep sloped mesas rise above the flat to gently rolling plains. This benching is the result of erosion-resistant limestone cap rocks of the plateau and mesa-hill structures. These formations are generally composed of massive, structurally sound limestone or a mix of limestone and shale known as marl, which crumbles and weathers. Soil cover generally is shallow to moderately deep, clayey, and underlain by limestone bedrock. Major soil associations are described in Tazik et al. (1992).

Elevation ranges from 180 m (590 ft) to 375 m (1229 ft) above sea level with 90 percent of the area below 260 m (852 ft). Higher elevations occur on the western portions of Fort

Hood and the lowest at the Belton Lake shoreline adjoining the installation on the east. Surface water drains mostly in an easterly direction. Most slopes are in the two to five percent range. Lesser slopes occur along flood plains, while slopes in excess of 45 percent occur as bluffs along flood plains and as side slopes of mesa-hills.

Fort Hood lies in the Cross Timbers and Prairies vegetation area of Texas, which normally is composed of oak woodlands with grass undergrowth. Woody vegetation on the installation is derived mostly from the Edward's Plateau vegetation community to the southwest and is dominated by Ashe juniper, live oak, and Texas oak. The grasses are derived from the Blackland Prairie area to the east. Under climax condition, these would consist of little bluestem and Indian grass.

Maneuver Training

Maneuver training exercises are conducted at all unit levels to ensure a combat ready fighting force. Training programs focus on units attaining and maintaining proficiency in collective tasks that support mission essential tasks. Units involved in the training process span all echelons from section to corps. III Corps' primary training focus at Fort Hood is the brigade level and below.

Units train as they will fight. Training exercises replicate combat conditions as closely as possible. Combat effects such as smoke, noise, and simulated nuclear, biological, and chemical conditions are integrated into every training event to condition units for operations in a difficult, stressful battlefield environment. Trainers are careful not to "simulate" or "assume away" any facet of a training mission. For example, units conducting defensive operations "dig-in" vehicle fighting positions and actually emplace the barrier and obstacle plan in those areas which have been previously approved for sub-surface excavation by environmental and archaeological managers. This level of training realism ensures a high level of combat readiness.

Units train for combat in a task-oriented manner. Trainers integrate combat, combat support, and combat service support elements to conduct multi-echelon, combined arms training. Combined arms training involves formations that include members of the entire fighting force. Commanders synchronize the activities of these forces within a battlefield framework that includes maneuver and operations within the deep, the close-in, and rear battle areas. Such exercises involve greater depth and rapidity of movement dimensions and, therefore, also incur greater demands for concurrent land use.

Maneuver training areas are located west, east, and southwest of the Live Fire Areas (Fig. 1). Maneuver training areas constitute 53,300 ha (132,024 ac) or 61 percent of the entire installation. The West Range Maneuver Training Areas (Land Groups 4-6) provides excellent training opportunities for large armored and mechanized infantry forces. The training area averages seven to 10 km (4.2-6.2 mi) east to west and 30 km (18.6 mi) north to south. The area features a wide variety of terrain and vegetation characteristics that greatly enhance cross country, combined arms maneuver. Because of its large, contiguous size, this is the only maneuver area on Fort Hood capable of supporting brigade level operations.

The Northeast (Land Groups 1 and 2) and Southeast Range Maneuver Training Areas (Land Group 3) are divided by Belton Lake Reservoir. The northeast sector is heavily vegetated and cross-compartmentalized, providing limited value as a mechanized maneuver area. The southeast sector provides more favorable terrain for mechanized units, but is only four to seven km (2.5-4.3 mi) north to south and 15 km (9.3 mi) from east to west. Because of limited area, the Northeast and Southeast Range Maneuver Training Areas are best suited for unit assembly and logistical areas, artillery firing points, and company and platoon level mounted and dismounted training. Additionally, these eastern training areas support engineer, combat support, and combat service support training, and provide locations for amphibious and river crossing operations

The Southwest Maneuver Training Area is not used for maneuver training due to its small size and isolated location. The Southwest Maneuver Training Area (Land Group 7; "Southwest Fort Hood") is separated from the main cantonment area by U.S. Highway 190. This training area includes many restricted areas, including Robert Gray Army Airfield and the Ammunition Supply Point (ASP). The Southwest Maneuver Training Area is used primarily for small mechanized unit and dismounted infantry training and for logistical sites.

Live-fire Training

Weapons proficiency is a critical component of combat power. Fort Hood units train with the most modern and sophisticated weapon systems available. These weapons are constantly evolving to stay ahead of advancements in armament technology by threat forces. Fort Hood has some of the most modern live-fire training ranges in the world. These ranges provide realistic combat conditions and scenarios to train crews to exacting standards of gunnery proficiency as well as test the capabilities of new weapons systems. Live-fire training facilities must be continuously upgraded to keep pace with evolving technology and changes in war fighting doctrine. Fort Hood uses a 5-Year Range Modernization Program to manage upgrades and expansion of existing facilities and new construction projects to meet future training and evaluation requirements. Live-fire training facilities are located primarily in Live Fire Areas (LF) 80-93 and Permanent Dudded Area (PD94; Fig. 1).

The Live Fire Areas and PD94 (Fig. 1) cover about 24,000 ha (59450 ac) in the central portion of the installation, bounded on the east, west, and south by the East Range, West Range, and South Range roads respectively. Direct fire occurs inside these roads, and is directed towards PD94 and other target arrays. Indirect fire from artillery and Multiple Launch Rocket Systems (MLRS) is directed from numerous locations in surrounding maneuver areas. Much of the Live Fire Area provides a buffer zone for PD94 and has limited impacts from exploding ordnance. The Live Fire Areas provide training and evaluation facilities for all individual, crew-served, and major weapons systems, up to and including brigade live-fire. These Live Fire Areas are used by all active units assigned to III Corps and Fort Hood, as well as by attached units from the Army National Guard and the Army Reserve.

Modernized live-fire training facilities require continuous maintenance to maximize range design capability. Sensor devices must be serviced and cleared of concealing vegetation to ensure unimpaired operation. Target arrays must be visible at maximum engagement ranges. A program of range maintenance to routinely clear vegetation from target arrays and sensor devices is a critical component of range operation.

Aviation Training

Fort Hood has one of the largest military aviation commands in the United States. The aircraft, primarily rotary-wing, are some of the most modern and sophisticated in the world. Aviation units on Fort Hood train at all from individual through battalion/squadron.

The training tasks accomplished in the training areas (Fig. 1) include all tactical maneuvers in accordance with each aircraft's aircrew training manual and the unit's standard operating procedures. This includes nap-of-earth, contour, and low level flight. Fixed-wing aircraft of the Air Force and Air National Guard also conduct training missions in Fort Hood air space and use impact areas on the installation for weapons delivery practice.

Two major airfields are located on Fort Hood. The Hood Army Airfield is a 293 ha (726 acres) area located at the eastern end of the cantonment area. Hood Army Airfield is the primary airfield for rotary-wing air operations and has a 1436 m (4712 ft) runway. Robert Gray Army Airfield is an 867 ha (2147 acres) area located at West Fort Hood with a 3050 m (10,000 ft) runway. Several dirt landing strips are located on the installation for tactical air supply and support training.

Aircraft gunnery for AH-64 units is conducted on multi-purpose training ranges and PD94. However, the Dalton-Henson Range Complex (LF 80-82) is used most often for this training. Hellfire Missile Shots are conducted at Blackwell Multi-Use Range's Impact Area (PD94). Helicopter Door Gunnery is primarily conducted at Dalton Mountain Range or Crittenburger Range (LF 85-86). National Guard and Army Reserve units use the Dalton-Henson Range Complex for aviation training.

Operational Testing

Fort Hood's large maneuver and Live Fire Areas, coupled with III Corps modernized force, provide excellent conditions for operational testing of various weapons, equipment, and doctrine. The U.S. Army Operational Test Command (OTC) is a tenant activity located at West Fort Hood directly involved in training, doctrine, and combat development of the products that soldiers use on a daily basis and will use on the future battlefield.

Most OTC tests employ "user testing," allowing front-line soldiers to try out new equipment or concepts. The tests generally encompass activities similar to those described in this report's sections on maneuver, live-fire, and aviation training.

Controlled/Prescribed Burning

Prescribed fire is a natural, economical, and effective management practice in some ecosystems. During the past 150 years in Texas, fire suppression practices have contributed substantially to the ecological imbalance of endangered species habitats. In many instances, properly applied fire can be one of the better tools to correct this problem. Fire presents a particular dilemma for the management of endangered species on Fort Hood. Recovery times differ for golden-cheeked warbler and black-capped vireo habitats after a stand-replacing fire. Golden-cheeked warbler habitat that burns on Fort Hood generally regenerates first as black-capped vireo habitat in two to five years. Regeneration to golden-cheeked warbler habitat can require 25 or more years post-disturbance. Because of fire's potential effects, both positive and negative, on endangered species habitats, it plays an important role in management of endangered bird species habitats on Fort Hood.

During extremely hot and dry conditions in late February 1996, approximately 2728 ha of endangered species habitat were burned by wild fires on Fort Hood. This included about 2313 ha of warbler habitat and 415 ha of vireo habitat. The golden-cheeked warbler habitat that burned substantially converted to black-capped vireo habitat during the subsequent 2-5 years.

New fire protection policies have been implemented on Fort Hood as a result of the 1996 fires and consultation with the USFWS. Fort Hood currently has a fire danger rating system to alert trainers when pyrotechnic operation should be limited or halted based on current (daily) weather and estimated moisture content of vegetation and soil. Details of this rating system are found in OPLAN 8-93, “Operation Brush Fire” and Fort Hood Regulation 350-40. These fire ratings are:

Condition Green: No restrictions on training. Troops may use pyrotechnics and incendiary munitions for training.

Condition Amber: Caution must be taken in use of pyrotechnics. Aerial flares are not to be used outside the impact area. Other pyrotechnics are to be used only in roadways, tank trails, in areas clear of vegetation, or in containers.

Condition Red: No pyrotechnics or incendiary munitions authorized for training purposes.

Condition Red with Waiver: Once a risk assessment is conducted by Range Control and the recommendation for training with waiver is approved by the Director, Range Control, specific restrictions are imposed on training units.

Currently, under all fire condition ratings, fires are reported to Range Control by military units or installation personnel. If the fires are within range fans where live-fire training is being conducted, units will cease firing until a fire risk assessment is conducted or control measures are implemented. Range Control will determine the location of the fire and risk to facilities, personnel, or sensitive resources such as endangered species habitats. If Range Control determines there is no risk to facilities or habitats, the fire will be allowed to burn. Typical examples are fires occurring in the permanently-dudded impact area (PD94; Figure 1) where fires are extremely frequent and fuel loads are low. If a fire may risk endangered bird habitat, Range Control will contact the installation Natural Resources Branch for an assessment of the risk based on proximity to high hazard areas, fuel load, topography and other parameters. If the fire risk to habitats is obviously high, Range Control may immediately implement fire control actions concurrent with notification of the Natural Resources Branch.

Under current procedures, fire control will be implemented under all fire condition ratings if a determination is made that endangered species habitat is at risk from a fire. Within the Live Fire Areas, the first response is usually by a contracted helicopter on standby for fire control. Under condition Red this helicopter is on 30-minute standby during 1100-1800 and two-hour standby during the rest of the day/night period. Other installation fire fighting assets are available for fire control as needed.

The proposed action will reduce requirements to conduct intensive fire suppression in Live Fire Areas during conditions Green and Amber. Fort Hood will establish a "let burn" policy for range fires that occur during periods when Fire Danger Rating is Green or Amber. Under Green and Amber ratings, fires will be allowed to burn in all habitat areas within the Live Fire Area unless there is obvious threat to personnel or facilities or until such time as changing environmental conditions warrant implementing increased fire control procedures.

Current prescribed burn fire policy emphasizes reduction of fuel loads in grasslands surrounding endangered species habitats on Fort Hood. Prescribed burn policies emphasize use of preventative prescribed fire to maintain blacklines near habitat areas annually. Fort Hood employs firebreaks in association with endangered species habitats to reduce fire risk. Reduction of fuel loads mitigates the threat of wild fire damage in these habitats. Prescribed burns are managed through the Fort Hood Natural Resources Branch. Other objectives of the installation prescribed burn program are to reduce encroachment of Ashe juniper in all range sites, improve vegetation composition and improve wildlife habitats.

Juniper Cutting

After the listing of the golden-cheeked warbler in May, 1990, juniper cutting on Fort Hood was suspended temporarily following informal consultation with the USFWS. Since Ashe juniper is an essential component of the habitat for this endangered bird species, it was determined that juniper cutting could have a negative impact.

During the period 1997-2000, under an agreement with the NRCS, Fort Hood resumed mechanical clearing of juniper in old-field and other areas not occupied by golden-cheeked warblers. These control efforts were focused on juniper removal on West Maneuver Training Areas and resulted in clearing juniper from approximately 14,500 ha (35,830 ac) from old fields and other non-endangered species habitat areas. All control efforts and contracts were coordinated through the Fort Hood Natural Resources Branch to avoid impact on endangered species habitats. Control efforts were not allowed within a 100 m (328 ft) buffer around endangered species habitats.

Grazing

Cattle grazing is permitted on Fort Hood under a lease agreement with the Central Texas Cattlemen's Association. The current lease extension expired September15, 2004. This lease provides grazing opportunities on80,000 ha (197,684 ac) of Fort Hood land. A new lease went into effect on 1 April 2005. Under the new agreement, stocking rates will be driven by the results of annual forage inventories. Grazing is deferred or stocking rate is reduced where forage production fails to meet thresholds that allow for training impacts and land management practices such as prescribed burning. The lease agreement requires the lessee not to impact endangered species, historical, archaeological, architectural, or other cultural features on the installation, and requires compliance with local, state, and federal water pollution regulations. A supplemental Environmental Assessment (SEA) and 'Finding of No Significant Impact' for the Fort Hood grazing program was issued in January 2004. On February 22, 2004, an additional supporting document titled "Points of Agreement Regarding Methodology for Calculating Animal Units for Grazing at Fort Hood, Texas" was signed by representatives from the Army, Fort Hood, and the Texas Department of Agriculture. The methodologies outlined in this agreement will be used to determine the cattle stocking rate on the Fort based on available forage as discussed above, thus providing an adaptive management feature that will assist in minimizing impacts to listed species.

Cowbird Control Program

Fort Hood conducts extensive operations to reduce numbers of cowbirds (*Molothrus* spp.) on the installation. The objective of the control program is to maintain the incidence of cowbird parasitism of black-capped vireo nests below 10 percent annually, averaged over

5-year periods. This program implements trapping and shooting activities that target feeding concentrations of cowbirds throughout the installation cowbird individuals in endangered species nesting habitat. Summers and Norman (2003) provide details on the current implementation of the control program. In 2004, over 2700 female brown-headed cowbirds were removed on Fort Hood during the warbler/vireo nesting season. Incidence of cowbird parasitism on black-capped vireo nests on Fort Hood in 2005 was 8.0 percent.

Recreation

The post is open to public hunting and fishing. Access is regulated by the Range Control Division, Area Access office with the cooperation of Morale Support Activities and the Natural Resources Branch. Over 80,500 ha (198,920 ac) are managed for fish and wildlife, including 100 surface ha (247 surface ac) of lakes and ponds, 88 km (55 mi) of rivers and permanent streams, and 85 km (53 mi) of shoreline access to Belton Lake. In recent years, the installation has provided 90,000 fisherman-days and 45,000 hunter-days annually. White-tailed deer, wild turkey, migratory waterfowl, northern bobwhite, and mourning dove are hunted during restricted seasons. Deer and turkey hunts are carefully controlled. Small game hunting with shotgun is available in accordance with State of Texas seasons and bag limits.

Various low-impact outdoor recreation activities take place at the Belton Lake Outdoor Recreation Area located adjacent to TA 36. These include a swimming beach, camping, boating, trail bicycling, and cottage use. Boy Scout Camps are located in TA 36 and LTA 203. Hiking and nature observation activities are also allowed on many parts of the installation and are coordinated through Range Control Division. Mountain bike riding is restricted to a designated trail system at Belton Lake Outdoor Recreation Area. No off-road recreational vehicle use is permitted anywhere on the installation.

3 Species Accounts and Current Status on Fort Hood

Golden-cheeked Warbler

Nomenclature and Classification

Scientific Name: *Dendroica chrysoparia*
Family: Emberizidae
Original Description: Sclater and Salvin 1860
Type Specimen: Adult female collected by Osbert Salvin near Tactic, Vera Paz, Guatemala on 4 November 1859. Specimen in the British Museum 1885-3-8-262.
Current Federal Status: Endangered (55 FR 53153-53160 [27 December 1990]).
Past Federal Status: Emergency listing as Endangered (55 FR 18844-18845 [4 May 1990]); Category 2 (47 FR 58454 [30 December 1982], 50 FR 37958 [18 September 1985], 54 FR 554 [6 January 1989]).

History of the Taxon

The name of this species has not changed since the original description of a specimen collected in Guatemala (Sclater and Salvin 1860). The first U.S. specimen was collected by D.C. Ogden in Bexar County, Texas (Dresser 1865). The species may have originated as part of a superspecies complex including the black-throated green warbler, the Townsend's warbler, and the hermit warbler (Mengal 1964, Lytle 1994). The definitive and only major bioecological study of the golden-cheeked warbler was completed by Pulich (1976). Sections of this study have been updated in Ladd and Gass (1999).

Because of rapid urban development, there is considerable interest in the status of the species in the Austin-San Antonio corridor. The Army is conducting studies of the species on Fort Hood, Texas and the Camp Bullis Training Site of Fort Sam Houston, Texas.

FORT HOOD: Monitoring and research activities for the golden-cheeked warbler on Fort Hood were initiated in 1991 and continue through the present. Current and past research and conservation efforts include point count surveys to determine population trends, demographic and reproductive monitoring in selected study sites, research in habitat selection, studies to determine the effects of habitat fragmentation and wildfire on golden-cheek warbler demographics, and population viability analyses.

Description

The golden-cheeked warbler is a small, strikingly colored songbird approximately 13 cm in length, and 9 to 10 grams in weight. Detailed descriptions can be found in Pulich (1976), Oberholser (1974), and Ladd and Gass (1999). Adult males exhibit bright yellow cheeks outlined in black, with a black line through the eye. The upper parts, throat, neck, and upper breast are black with additional black streaking along the flanks. The wings are black except for two distinct white bars. The black tail is interrupted with white on the three outermost feathers. Adult female plumage is duller than that of the male, with a black-streaked olive back, a yellowish throat, and a blackish upper breast. The cheeks of female and immature birds are not as bright as that of the male. The back of immature birds also is streaked with green. Immatures often cannot be sexed based on plumage characteristics.

FORT HOOD: Plumage characteristics are consistent with those within the range.

Geographic Distribution

The golden-cheeked warbler is the only North American bird species whose breeding range is restricted to a single state (Texas). Its nesting range is confined to 33 counties in central Texas. Historically, it has been recorded in 41 of the 254 counties in Texas. It is a species characteristic of the Hill Country of central Texas, inhabiting mature juniper-oak woodlands of the Edward's Plateau. The range of the golden-cheek corresponds closely with that of ashe juniper (Pulich 1976).

Based on an extensive review of existing records, Pulich (1976) concluded that the species winters in mountainous areas (between 1400 and 2000 m; Thompson 1995) of east-central Guatemala through Honduras to Nicaragua, but that the exact winter range was not yet well defined. The presence of wintering birds in Mexico was considered questionable. However, more recent evidence suggests that the species may winter in the state of Chiapas in extreme southern Mexico (Braun et al. 1986, Johnson et al. 1988, Perrigo et al. 1990, Vidal et al. 1994).

FORT HOOD: Known distribution of potential warbler habitat on Fort Hood is based on visual interpretation of aerial photography and ground surveys (Fig. 2). Currently, it is estimated that approximately 21,422 ha (52,935 ac) of suitable golden-cheeked warbler habitat occur on Fort Hood (Hayden et al. 2001). Warbler occurrence is widespread and has been documented in all training areas with suitable habitat on the installation.

Migration

The golden-cheeked warbler is a migratory species that arrives early on its breeding grounds in Texas. The earliest spring arrival known to Pulich (1976) was a 2 March arrival in Austin during 1956. It is not certain whether male warblers arrive earlier than females. The mean spring arrival date for Bexar, Dallas, Kerr, and Travis Counties was between 12 and 16 March.

The species begins post-breeding migration rather early, with some birds headed toward their wintering grounds as early as mid June (Pulich 1976). The main portion of the population leaves the breeding grounds by the end of July (Ladd and Gass 1999). The earliest fall record in southern Mexico was 5 August (Ladd and Gass 1999).

FORT HOOD: The earliest documented spring arrival on Fort Hood is 2 March. Peak arrival period is between 15 and 25 March. Similar to other populations throughout the range, most warblers on Fort Hood begin migration by the end of July.

Habitat

General: The USFWS recovery plan provides a general overview of warbler habitat requirements (USFWS 1992). Golden-cheeked warbler habitat includes Ashe juniper and a variety of oak species. Several other hardwood species also occur (Pulich 1976). Fifteen stands sampled by Wahl et al. (1990) were dominated by Ashe juniper and Texas oak. Other important tree species included live oak, cedar elm, Lacey oak, Arizona walnut, post oak, and bigtooth maple. Studies by Johnston et al. (1952) and Huss (1954) reported juniper-oak stands occupied by the golden-cheek with juniper composition of 14 to 50 percent and hardwood composition of 20 to 70 percent. For good warbler habitat at Meridian State Recreation Area, Kroll (1980) reported 52 percent Ashe juniper, 33 percent shin oak, and 5 percent Texas oak. Similarly, the most important species in warbler habitat at Kerr Wildlife Management Area were Ashe juniper, Texas oak, and shin oak (Ladd 1985). While Ashe juniper is the dominant woody species throughout the warbler range, the composition of oak species varies geographically (Ladd 1985, Ladd and Gass 1999).

Pulich (1976) suggested that the golden-cheeked warbler requires woodland habitat with junipers averaging 50 years of age and 20 feet in height with some deciduous cover. Kroll (1980) quantified habitat of the species at Meridian State Recreation Area and found that 86 percent of the junipers within the study area were less than 50 years old (average 40.8 ± 29.4 years). Good habitat that was consistently occupied from year to year differed significantly from unoccupied areas. Good habitat was characterized by older Ashe juniper (mean of 47.4 versus 25.6 years of age in good vs. poor habitat) but a greater variability in age, greater distance between trees, and a smaller juniper:oak density ratio (1.35 vs. 2.77). The warbler appears to be attracted to more mesic areas within the juniper-oak complex, such as canyons and seepy hill sides where deciduous hardwood vegetation is more abundant (Diamond, personal communication). Recent observations indicate warblers will reoccupy second growth areas (Ladd, personal communication, Diamond, personal communication) presumably in areas that have the appropriate mixture of juniper and deciduous oaks. Arnold et al. (1996) reported that 23 ha may be the minimum threshold size of habitat in which golden-cheeks can produce young. Coldren (1998) found that golden-cheeked warblers select for habitat patches > 100 ha.

FORT HOOD: Warblers on Fort Hood occupy similar habitat to that described above.

Nest Sites: Chapman (1968) reported that the favorite nesting areas of the golden-cheek were "isolated patches or clumps of scrubby cedar, with scant foliage on the summits of the scarped canyon slopes and in the thick cedar 'brakes' ." Nests are placed in juniper trees and a variety of hardwood tree species (Chapman 1968, Pulich 1976). Nest height varies from 1.8 to 6.5 m, averaging 4.6 m (Brewster 1879, Chapman 1968, Pulich 1976). Nests average eight cm in external width and five cm in external depth. They are composed mostly of bark collected in strips from juniper trees. Kroll (1980) estimated that juniper bark does not start to peel sufficiently for warblers to collect until juniper trees are about 20 years of age.

FORT HOOD: Nests have been found in Ashe juniper, Texas oak, post oak, Texas ash, shin oak, black jack oak, red elm, cedar elm, hackberry and live oak trees. Nest heights ranged from 2.0 m to 14.7 m, with an average height of 5.2 m (R. Peak, personal communication).

Foraging Site: The golden-cheeked warbler forages for insects in tree canopies (Smith 1916, Simmons 1924, Pulich 1976). Essential foraging habitat is provided by oak species within the habitats occupied (Kroll 1980, Ladd 1985, Wahl et al. 1990). Beardmore (1994) reported that oaks were used out of proportion to availability during April, but in proportion to availability during May and June. Fifty-seven percent of the foraging observations made by Kroll (1980) found warblers in oaks. Beardmore (1994) also reported foraging differences between male and female golden-cheeked warblers.

FORT HOOD: No data are available on foraging preferences on Fort Hood although foraging behavior is likely similar to that observed in other parts of the warbler's range.

Food Resources

The golden-cheek is considered a generalist, consuming a wide variety of arthropods including Lepidopterans, Coleopterans, Hemipterans, Homopterans, Hymenopterans, Dipterans, Psocopterans, and Arachnids (Pulich 1976, Wharton et al. 1996). Kroll (1980) observed that most prey items used by the warbler were of Lepidopteran larvae (54 percent) and Orthopterans (13 percent).

FORT HOOD: No data are available on food resources on Fort Hood although food resources are likely similar to that observed in other parts of the warbler's range.

Population Estimates

Pulich (1976) estimated that the breeding population of the warbler in 1962 and 1974 was between 15,000 and 17,000 birds. Wahl et al. (1990) estimated a range of 4822 to 16,016 individuals in 1989. The two estimates are not directly comparable, because they were derived in different ways (Wahl et al. 1990). Also, Wahl et al.'s estimate may be inflated since not all males are mated and all available habitat may not be fully occupied at the assumed average density of 15 pair per 100 ha.

Population estimates were derived from estimates of habitat availability and population density. Most studies report golden-cheek territory sizes ranging from 1.9 to 4.3 ha per pair (Ladd 1985). Wahl et al. (1990) reported density estimates of zero to 62.5 males per 100 ha with a median of 15 per 100 ha for several sites throughout the golden-cheeked warbler's range. Pulich (1976) classified warbler habitat into excellent, average, and marginal corresponding to 12.3, 5.0, and 2.9 pair per 100 ha.

FORT HOOD: Between 1992 and 2005 the mean number of golden-cheeked warblers reported on point count transects increased (Fig. 3). The 2005 mean number of detections/point was 1.154 (Peak 2005a).

Currently, it is estimated that approximately 21,422 ha (53,935 ac) of suitable golden-cheeked warbler habitat occurs on Fort Hood (Fig. 2). Using golden-cheeked warbler densities from intensively studied areas, the population on Fort Hood is estimated to range from 2,901 to 6,040 singing males. Observed density in 2005 on intensive study plots was 0.24 males/ha (Peak 2005b), which extrapolated to all available habitats would produce an estimate of 5,141 territorial males.

Survival and Dispersal

One-year banding returns reported by Pulich (1976) were 44.8 percent for males and 22.2 percent for females. USFWS (1996) estimated 30 percent juvenile and 57 percent adult annual survival.

FORT HOOD: USFWS estimates of juvenile and adult survival were based on mark-recapture analysis of Fort Hood banding return data (USFWS 1996). In the intensive study area in TA 13B, one-year banding returns of adult males ranged from 30 percent (15 of 50 males) in 1996 to 65.6 percent (21 of 32 males) in 1995, averaging 48 percent (61 of 127) for the period 1992-96 (Jette, Hayden and Cornelius 1998). Return rates of adult males during 2000-2005 (Fig. 4) ranged from 23.5 percent in 2005 to 50 percent in 2001 (Peak 2005b)

Reproductive Biology

The golden-cheeked warbler is sexually monogamous. Individual pairs establish exclusive breeding territories within which they nest and forage. The nesting cycle is as follows: construction (4-5 days), inactive construction (3-4 days), laying (4 days), incubation (11-12 days), nestling (9 days), fledgling feeding (28-45 days). Some nest construction may be initiated during late March, but most occurs during early April (Pulich 1976). Clutches typically consist of four eggs, sometimes three, and rarely five. The species is not commonly double-brooded, although pairs will renest after a failed nesting attempt.

The female performs most of the nesting duties (Pulich 1976). While males assist in feeding young during the nestling stage, they do not brood the young.

Of the 33 nests observed by Pulich (1976), 58 percent were parasitized by brown-headed cowbirds (cowbirds hereafter). Of the 55 eggs laid, 55 percent were lost or deserted due to cowbirds. Twenty seven percent of the eggs laid fledged young.

FORT HOOD: Nest success was 60.8 percent in 2005 and did differ among years, 2000-2005 (Fig. 4, Peak 2005b). Pairing success was 88.5 percent in 2005 and did not differ among years, 2000-2005 (Fig. 5, Peak 2005b). During 1992-96, observed mating success ranged from 79 to 94 percent, with overall average mating success of 89 percent for adult males (Jette, Hayden and Cornelius 1998). A total of 315 warbler nests were found on Fort Hood between 1991 and 2005. Golden-cheek young fledged from 210 nests. Cowbird parasitism of golden-cheeked warbler nests has been observed on Fort Hood. In 60 nests in 2005 where clutches were initiated there was no evidence of nest parasitism by brown-headed cowbirds (Peak 2005b). Cowbird parasitism of golden-cheeked warblers on Fort Hood has been documented in other years but incidence appears low (Hayden et al. 2001).

Interactions with other Species

Habitat Associates: Other breeding birds found in association with the golden-cheek throughout most of its range include the black-and-white warbler, mourning dove, yellow-billed cuckoo, greater roadrunner, eastern screech owl, great-horned owl, barred owl, American crow, red-tailed hawk, red-shouldered hawk, common grackle, blue jay, western scrub jay, cliff swallow, chuckwill's widow, Carolina chickadee, Bewick's wren, Carolina wren, canyon wren, northern flicker, downy woodpecker, eastern tufted titmouse, blue-gray gnatcatcher, white-eyed vireo, brown-headed cowbird, summer tanager, northern cardinal, painted bunting, and lark sparrow (Pulich 1976, Arnold et al. 1996, Jette personal communication).

Arnold et al. (1996) reported that, of the 23 predators and parasites found in association with the golden-cheek, only the brown-headed cowbird, greater roadrunner and red-tailed hawk were found more frequently with warblers than without.

FORT HOOD: Similar habitat associates are observed on Fort Hood.

Competition: There probably is little competition from others of the same family as the golden-cheek occupies such a narrow ecological range (Pulich 1976).

FORT HOOD: Aggressive interactions are observed between closely related black-throated-green warblers and golden-cheeked warblers on Fort Hood during migration. Black-throated-green warblers are not resident breeders in Texas. No aggressive interactions have been observed with other species.

Depredation: Direct depredation on adults has not been observed frequently. However, nests are depredated by snakes, grackles, jays, and possibly squirrels (Pulich 1976, Pease and Gingrich 1989). Red fire ants are a potential problem (Pulich 1976).

FORT HOOD: Stake et al. 2004 monitored 67 golden-cheeked warbler (Dendroica chrysoparia) nests with infrared video cameras and time-lapse recorders to identify predators. Rat snakes (Elaphe spp.) were the most frequent predators, depredating 12 nests and capturing three adult females. A variety of avian predators depredated seven nests, including three American Crows (Corvus brachyrynchos), two Brown-headed Cowbirds (Molothrus ater), one Western Scrub-Jay (Aphelocoma californica), and one

Coopers Hawk (Accipiter cooperii). Fox squirrels (Sciurus niger) depredated four nests and were the only mammalian predators recorded. Post-outcome recordings (i.e., after young fledged or nests failed) revealed western coachwhips (Masticophis flagellum testaceus), mice (Peromyscus sp.), and Greater Roadrunners (Geococcyx californianus) as potential predators, though they were not recorded at active nests.

Parasites: Pulich (1976) observed no mites or ectoparasites in golden-cheeked warbler nests.

FORT HOOD: Small white mites have been observed on the rectrices of adult warblers during banding. No other data are available on parasites of warblers on Fort Hood.

Threats to Survival

Threats to golden-cheeked warbler identified in the 1994 Recovery Plan (USFWS 1992) included breeding habitat loss, loss of winter and migration habitat, habitat fragmentation, nest parasitism by cowbirds, and destruction of oaks. A more recent population viability and habitat assessment (USFWS 1996) also identifies concerns related to reservoir development, oak wilt, predation, and secondary effects of urbanization in proximity to warbler habitats.

Habitat loss is attributed to urban development and clearing associated with agricultural practices. Pulich (1976) estimated a juniper eradication program for range improvement reduced juniper acreage in Texas by 50 percent between 1950 and 1970. Wahl et al. (1990) reported warbler breeding habitat loss of approximately 4 percent per year over a 10-year period in urbanizing areas and about 2 to 3 percent per year in rural areas during the past 20 years. This work was based on satellite imagery from 1974 through 1981. More recent satellite imagery may show that the rate of habitat loss has increased in recent years (Grzybowski et al. 1990). Estimates of loss of wintering habitat in Central America (two to four percent per year) are similar to estimated losses of breeding habitat (Jahrsdoerfer 1990, Lyons 1990).

Loss of habitat has resulted in increased fragmentation of warbler habitat. Wahl et al. (1990) estimated a 53 to 84 percent reduction in suitable habitat (> 50 ha in size) due to habitat fragmentation around urban areas and a 56 to 89 percent reduction in rural areas. Habitat fragmentation has been suggested as a cause of population declines in other songbird species, (Gates and Gysel 1978, Brittingham and Temple 1983, Wilcove 1985, Andren and Angelstrom 1988, Pease and Gingerich 1989). However, habitat fragmentation may make warblers more susceptible to depredation by blue jays in urban areas (Engels and Sexton 1994) and more susceptible to nest parasitism by cowbirds (Brittingham and Temple 1983, Robbins et al. 1989, Thompson 1994). Coldren (1998) found that golden-cheeked warblers selected for habitat patches > 100 ha and that territory placement selected against urban land uses including commercial development, entertainment, forested non-warbler habitat, high-density transportation, and utilities.

Cowbird parasitism reduces productivity in host species (Brittingham and Temple 1983).

Golden-cheeked warblers are susceptible to cowbird parasitism (Pulich 1976). Land use practices which increase the incidence of cowbird parasitism such as habitat fragmentation, cattle grazing, and increased urbanization may limit productivity in golden-cheeked warblers.

Oaks are a necessary component of warbler habitat. Loss of oaks in warbler habitat is attributed to disease (oak wilt fungus, *Ceratocystis* spp.) and over-browsing by white-tailed deer, goats, and various exotic ungulates.

FORT HOOD: There has been no evidence to date of overbrowsing of oaks on Fort Hood (J. Cornelius, pers. comm.). Incidence of oak wilt fungus has been observed on Fort Hood and its further spread is being monitored and treated. Studies on Fort Hood to determine the efficacy of basal girdling to control spread of oak wilt were conducted in 2004 and 2005 (Reemts et al. 2005). Treated plots had a lower incidence of new infections compared with control plots. While there have been no juniper eradication contracts in warbler habitats on Fort Hood since 1990, junipers are cleared from old fields that are not suitable as warbler habitat. The only significant loss of warbler habitat comes from fires. Warbler habitat is not altered significantly by military training since vehicle transit is limited through the dense vegetative growth typical of warbler habitat. Maas-Burleigh (1997) reported that golden-cheek males in more fragmented landscapes on Fort Hood reproduced less often than males in contiguous forest.

Black-capped Vireo

Nomenclature and Classification

Scientific Name: *Vireo atricapilla* Woodhouse
Family: Vireonidae
Original Description: Woodhouse 1852
Type Specimen: Adult male collected by S. W. Woodhouse on 26 May 1851 at the San Pedro River 10 miles from its source - Devil's River, near Sonora, Sutton County, Texas (Deignan 1961). Deposited in the National Museum of Natural History, number 15040.
Current Federal Status: Endangered (52 FR 37420-37423 [6 October 1987]).
Past Federal Status: Category 2 (47 FR 58454 [30 December 1982]); Category 1 (50 FR 37958 [18 September 1985]).

History of the Taxon

Grzybowski (1995) provides a recent account of this species. The species was first described by Woodhouse (1852). The name has remained unchanged since his original description. Until recently, there were few major studies of the black-capped vireo. Bunker (1910) first studied nesting, stomach contents, and plumage of the vireo in Blaine County, Oklahoma. In another study, Graber (1957, 1961) examined distribution, ecology, and population biology of the species. Marshall et al. (1985) wrote a profile of the species, focusing on the distribution and abundance in the United States and Mexico. Grzybowski has continued studies on the species in parts of Texas and Oklahoma, and authored the species Recovery Plan (USFWS 1991) and the species account for the Birds of North America publication (Grzybowski 1995). Tazik (1991) initiated research on one of the largest concentrations of nesting black-capped vireos north of Mexico, on Fort Hood, Texas. Recent research efforts include a study of alternative host densities and the incidence of cowbird parasitism in black-capped vireos by Barber and Martin (1997), the effects of prescribed burning on black-capped vireo habitat and vireo nesting dynamics by O'Neal et al. (1996), and a population estimate for the breeding population in Mexico by Benson and Benson (1990). Army-sponsored studies are on-going at Fort Hood, Texas; Camp Bullis Training Site, Texas; Fort Sam Houston, Texas; and Fort Sill, Oklahoma. Other monitoring and research activities are conducted on other local, state and Federal properties in Texas.

FORT HOOD: Research and conservation efforts on Fort Hood have included an inventory and monitoring program, remote camera studies of nest depredation and assessment of training activities in endangered species habitats, a habitat restoration program, a study of researcher activities on nesting vireos, a nest site/habitat analysis, assessment of cowbird movements and activity, and a cowbird parasitism control program.

Description

The black-capped vireo is a small songbird approximately 11 cm in length and 10 grams in weight. The sexes are dimorphic. On the adult male, the crown and upper half of the head is black and sharply demarcated. Black extends farther posterior on older males. The back is olive-green and undersides are white with olive-yellow flanks. Wings have olive-yellow-black plumage colors with two light yellowish wing bars. The adult female is similar in color except for a gray crown, often with some black around the white eye mask, and under parts washed with greenish yellow. Adults have a red to reddish-brown iris. Immature birds are browner above, and buffy below (Grzybowski 1995).

FORT HOOD: Black-capped vireos on Fort Hood are similar in appearance to the description above.

Geographic Distribution

The breeding range of the black-capped vireo formerly stretched from south-central Kansas through central Oklahoma and central Texas into central Coahuila, Mexico, and possibly Nuevo Leon and Tamaulipas (Graber 1961, American Ornithologists Union 1983). The northern extent of the range has contracted significantly over the past half-century (Grzybowski 1995, Grzybowski et al. 1986). The species has not been observed in Kansas since the late 1950s (Tordoff 1956, Graber 1961) and reaches its northern limit in Blaine County, Oklahoma (Grzybowski et al. 1986). The vireo appears to be gravely endangered in Oklahoma (Grzybowski et al. 1986, Grzybowski 1987, Ratzlaff 1987) and is declining in many areas of Texas (Grzybowski 1995, USFWS 1991). Black-capped vireos have been reported in at least 40 counties in Texas (Beardmore and Hatfield 1995).

FORT HOOD: A single black-capped vireo vocalization was reported in a 1979 baseline ecological report for Fort Hood. Vireos were subsequently observed in 1985 by John Cornelius, a biologist with Natural Resources Branch at Fort Hood. These initial findings comprised a small number of birds (Tazik et al. 1993a). Inventory, monitoring, research efforts were initiated in 1987 and continue through the present. Current known vireo habitat on Fort Hood is shown in Fig. 2. Vireos are known to exist elsewhere on the installation, but are typically isolated territories within habitat shown in Fig. 2 as golden-cheeked warbler habitat.

Migration

The black-capped vireo is migratory and is known to winter along the western coast of Mexico from Sonora to Oxaca (Graber 1961). Although extensive winter surveys have not been done, most observations have been recorded in Sinaloa and Nayarit (Grzybowski 1995). Vireos first arrive on Texas breeding areas during late March to mid-April, and in Oklahoma during mid-April to early May (U.S. Fish and Wildlife Service 1991). Fall migration takes place during August and September. Graber (1961) reports that young birds leave first, followed by adult females, and then adult males.

FORT HOOD: On Fort Hood, males typically are first observed in late March or early April. It is suspected that females arrive shortly thereafter. Many males are no longer strongly territorial by the end of July, although some have nested into August. Most black-capped vireos appear to have departed by mid-September.

Habitat

General: The black-capped vireo is found in hardwood scrub habitat that typically exhibits a patchy or clumped distribution with a scattering of live and dead trees. Characteristic is the presence of hardwood foliage to ground level. Scrubby oaks are a major feature of the habitat. Blackjack oaks are dominant in Oklahoma. Shin oak, Texas oak, and live oak are the dominant oaks in vireo habitats in Texas (Graber 1961, Grzybowski 1986, Grzybowski et al. 1994). Dense juniper stands typically are avoided. In the eastern parts of the range, preferred habitat often results from fire within stands of mature oak-juniper and remains suitable for five to 25 years after fire. In the arid western portions of the range, shrub habitats occupied by the vireo represent climax conditions rather than early seral habitats (D. Diamond, personal communication). The best vireo habitats found by Marshall et al. (1985) were in 10- to 15-year-old burns that were hot enough to kill junipers. Data from some study sites indicated that there were significant differences with regard to the vegetation structure in territories held by first year males compared to those held by older males (Grzybowski et al. 1994). First year males tended to occupy areas that were more open floristically

FORT HOOD: Black-capped vireo habitat at Fort Hood typically is shrubby, and ephemeral with a "clumped" vegetation structure. Most habitat patches were caused by accidental fires or mechanical clearing related to military training and operations. Sites are generally occupied by vireos from four to 25 years following disturbance. The most common tree/shrub species found in black-capped vireo habitat on Fort Hood were shin oak, flameleaf sumac, Ashe juniper, Texas oak, skunkbush sumac, redbud and Texas ash (Tazik et al. 1993b). Tree/shrub species composition on vireo territories is variable, and that habitat structure (i.e. presence of low hardwood scrub) is a more critical factor in habitat selection than species composition (Tazik et al. 1993b).

Based on an installation-wide survey conducted in 2002 and 2003, the current estimate of suitable black-capped vireo habitat on Fort Hood is 6,967 ha (17,216 ac). Approximately 90 percent of suitable habitat is estimated to be occupied by black-capped vireos (Cimprich 2003).

Nest Site: The nest is open-cupped and pensile, about 5.8-6.2 cm in depth and 5.9 cm wide, and typically is located 0.5 to 1.5 meters above ground (Graber 1961). In areas of oak-juniper habitat, nests consist largely of dried grass and leaves bound with spider web. Other materials may include plant fibers, cottony plant substances, paper, wool, and caterpillar silk. A variety of woody species common to the general habitat are used as nest substrates. As with the species composition of the general habitat, nest substrates vary geographically. Blackjack oak is the most frequently used species in Oklahoma while shin oak and Texas oak are frequently used in Texas (Graber 1961, Grzybowski 1986). Juniper and live oak are used but less than in proportion to availability (Grzybowski 1986).

FORT HOOD: Nest construction on Fort Hood is similar to that observed throughout the species' range. Mean nest height in 2005 was 0.83 m (Cimprich 2005). Nest substrates include shin oak, Texas red oak, Texas redbud, Ashe juniper, Texas ash, plateau live oak, cedar elm, rusty blackhaw, Mexican plum, evergreen sumac, elbow-bush, hackberry, Texas persimmon, skunkbush, Mexican buckeye, Carolina buckthorn, blackjack oak (Cimprich 2005).

Foraging Sites: The vireo is a foliage-gleaning insectivore that forages among the trees and shrubs in its habitat. It rarely feeds on the ground (Graber 1961). Foraging substrate preferences have not been quantified but may prefer deciduous substrates such as oaks (Grzybowski 1995).

FORT HOOD: Little is known of the foraging substrates at Fort Hood, but low hardwood vegetation appears to be used (Tazik et al. 1993b). Vireos have also been observed foraging in taller junipers and oaks when tending fledglings.

Food Resources

Graber (1961) quantified the stomach contents of 11 black-capped vireos. Insect larvae constitute the bulk of the diet. Lepidopteran larvae predominate followed by Coleopteran larvae. Other animal matter includes spiders, centipedes, Neuroptera, Odonata, Hemiptera, and Homoptera. The young are fed small larvae, with food items increasing in size as the young grow. Grasshoppers and other Orthopterans may contribute as much as one-third of their diet.

FORT HOOD: Dietary studies of the black-capped vireo have not been conducted at Fort Hood but diet is likely similar to that observed in other parts of the vireo's range.

Known Population

The known population consists of populations in Oklahoma, Texas, and Mexico. Grzybowski (1995) in his review of the species, cites data collected in 1990 to 1994 and reports three populations in Oklahoma; one had 20 - 30+ adults, a second where 150 breeding females were documented, and a third that consisted of a very small group of birds. He also cites reports of <150 adults in the Austin area of Texas (in 1989) and 450 adults in Kerr County, Texas (in 1990). Other sites in Texas contributed a count of 357 males at Fort Hood in 1997 (The Nature Conservancy 1998) and 12 males at Camp Bullis/Fort Sam Houston in 1997 (Weinberg 1998). The estimated population in Mexico is described in Benson and Benson (1990) and was based on 28 confirmed birds, which the authors extrapolated out to an estimate of 3,139 - 9463 pairs. See Scott and Garton (1991) and Benson and Benson (1991) for comments and details regarding the methods for the estimate.

FORT HOOD: Distance sampling at 850 points yielded an estimate of 4,834–8,261 male black-capped vireos present on Fort Hood in 2005 outside of the Live Fire region (Cimprich 2005). No trends were detected in black-capped vireo abundance from 1998 through 2005 (Cimprich 2005).

Territory Size and Density

Graber (1961) reported an average territory size of 1.5 ha. Mr. Jim O'Donnell reported an average territory size of about 3 ha in Travis County, Texas (In Marshall et al. 1985). Graber (1961) also reported that the smallest breeding population she ever found consisted of five males and three females.

FORT HOOD: At Fort Hood, Tazik and Cornelius (1993) reported an average territory size of 3.6 ha, ranging from 1.9 to 7.0 ha. Density estimate in 2005 was .51 males/ha in intensively monitored sites (Cimprich 2005). In contrast to Graber (1961), at Fort Hood there are regular observations of only one or two pairs at a given location. These isolated territories have been successful in fledging young.

Survival

Graber (1961) found that 69 percent of the males that she banded returned the following year, but that only 41 percent of females returned. Grzybowski (1990) reported a similar difference between sexes; 65 percent for males versus 41 percent for females in main colony sites in Texas. One-year returns in the Wichita Mountains of Oklahoma were 62 percent for males and 44 percent for females (Grzybowski 1989a). The difference between sexes may be due to several factors: greater inconspicuousness of females compared to males, less site tenacity on the part of females, or a real difference in survivorship between the sexes. Lower survivorship among female songbirds has been reported by others (Nice 1937, Stewart and Aldrich 1951, Nolan 1978). Juvenile survivorship is at least 24 percent (Grzybowski 1995) but may be in the range of 35 to 55 percent (Grzybowski and Pease, personal communication). Grzybowski (1995) indicates that 96 percent of the males greater than one year old were site faithful, while many yearling males exhibited less site tenacity and a greater degree of dispersal or wandering. Gryzbowski (1990) found return rates in small "satellite" populations to be lower than those in main "colonies". This might be due to differences in site tenacity more so than differences in survivorship between the two population types.

FORT HOOD: Fort Hood estimated return rates of adult black-capped vireos in 2005 were 42 percent for males and 18 percent for females. In general, these return rates of banded black-capped vireos to study areas have been consistent since 1997 (Fig. 6, Cimprich 2005).

Reproductive Biology

Within a breeding season, black-capped vireos are monogamous or sequentially polygamous (Grzybowski 1995). Individual pairs establish breeding territories. The nest cycle includes construction (4-5 days), inactive construction (1 day), laying (4 days), incubation (14-17 days beginning after the second or third egg laid), brooding of nestlings (11 days), and fledgling (40+ days) (Graber 1961). The male is involved in all stages of the nesting cycle. Both sexes participate in nest building although the female performs more of the construction as the male often pauses to sing and defend the territory (Graber 1961). The male conducts about one-third of the incubation. Upon hatching, the chicks are brooded by the female while the male furnishes about 75 percent of the food for the young. Pairs frequently renest after both successful and unsuccessful nest attempts.

Reproductive success reportedly has been poor throughout the range of the vireo due largely to the impact of brown-headed cowbird brood parasitism (Graber 1961, Grzybowski 1995, Grzybowski et al. 1986, Grzybowski 1988, 1989b, 1990). In one example, Graber (1961) observed a sample of 76 nests containing a total of 243 eggs. Only 17.6 percent (43 eggs) produced fledglings. Of the 134 eggs lost prior to hatching, 72.3 percent were lost to cowbird activity. Only nine percent of eggs were lost to predators. Among the 95 eggs that hatched young, 26.3 percent were lost due to the presence of cowbird young in the nest, while 16.8 percent were lost to predators. In all, 19.7 percent (15 of 76) of nests in which eggs were laid and 59.7 percent of mated pairs (46 of 77) were successful in fledgling at least one vireo. A total of 43 young were fledged for an average production of 0.56 young per pair per year. In another example, Grzybowski (1990) reported production of 0.92 to 2.58 young per pair in areas with cowbird removal and zero to 0.38 young per pair in areas without cowbird removal during 1988. During 1989, production was 2.00 to 3.78 in removal areas compared to 1.27 to 1.44 in nonremoval areas. In Oklahoma, production was 1.37 with cowbird removal, 0.36 without removal (Grzybowski 1990). Other productivity reports include 0.82 to 1.76 on three areas managed by the Texas Parks and Wildlife Department (Bryan and Stuart 1990), and an average of 1.0 to 1.4 young per pair per year (with cowbird egg removal) at Fort Sill, Oklahoma, during the period 1988 through 1990.

FORT HOOD: At Fort Hood, black-capped vireos appear to be primarily monogamous; however, sequential polygamy has been commonly observed.

Nest parasitism by cowbirds has been severe at times on Fort Hood, particularly in the initial years of the monitoring program. Mitigation of that phenomenon has been an integral component of the management strategy and nest parasitism rates at Fort Hood have dropped dramatically. In 1987 and 1988 nest parasitism rates were about 90 percent. In 1993, 1994, and 1995 those rates dropped to 25.8, 12.8, and 15.2 percent, respectively. Mean parasitism rates in non-live fire areas were 6.3% during 2001-2004 (Summers and Norman 2004). The incidence of parasitism in 2005 was eight percent (Cimprich 2005). Nest success rates mirrored those trends. In 1987 and 1988, nest success rates were less than five percent, while they were between 32.7 and 55.6 percent during the period 1993-1995 (Weinberg et al. 1998). Cimprich (2002, 2003, 2004) reported a success rate of 61% in 2002, 38% in 2003 and 47% in 2004. Observed nest success in 2005 was 25 percent (Cimprich 2005). The increase in nest success was attributed to aggressive cowbird trapping and shooting efforts conducted by Fort Hood biologists. A strong negative correlation exists between the number of female cowbirds trapped during the black-capped vireo breeding season and the incidence of cowbird parasitism of black-capped vireo nests from 1987–2004.

In 2005, 40 percent of territorial males succeeded in producing =1 fledglings. Successful nests produced a mean of 3.22 fledglings, and territorial males produced an average of 1.13 fledglings over the entire season (Cimprich 2005). No trend in daily nest survival estimates has been found since 1997 (Cimprich 2005).

Monitoring at study sites at Fort Hood has revealed a pattern of seasonality in nest parasitism While 48.7 percent of the vireo nests were initiated during April, only 5.9 percent were parasitized during that period. The vast majority of parasitism events (82.4 percent) occurred between May 1 and June 10, when only 45.5 percent of the vireo nests were initiated (Weinberg et al. 1998). This apparent "parasitism-free period" in April is concordant with the possibility that the cowbirds breeding period coincides with the period of greatest host nest density (see Robinson et al. 1995). This is supported by Barber and Martin's (1997) finding that the incidence of nest parasitism in black-capped vireo nests on Fort Hood was correlated with the cumulative density of alternative hosts.

Interactions with Other Species

Habitat Associates: The black-capped vireo co-exists with a wide variety of other species within its habitat. The particular composition of associated species differs somewhat geographically (Graber 1961).

FORT HOOD: Some characteristic associates of the black-capped vireo on Fort Hood include northern cardinal, tufted titmouse, blue-gray gnatcatcher, white-eyed vireo, northern mockingbird, yellow-breasted chat, brown-headed cowbird, painted bunting, rufous-crowned sparrow, field sparrow, and Bewick's wren.

Competition: Territories of the black-capped vireo sometimes overlap with that of the white-eyed vireo or Bell's vireo. No direct competition with other species was observed by Graber (1961).

FORT HOOD: At Fort Hood, a black-capped vireo was observed chasing a white-eyed vireo (J. Cornelius, personal communication). In 2002, a white-eyed vireo initiated a clutch in a nest that was initially constructed by a black-capped vireo (T. Hayden, unpublished data).

Depredation: Direct depredation on adult birds has rarely been observed.

FORT HOOD: Stake and Cimprich (2003) monitored 142 black-capped vireo nests at Fort Hood, Texas, from 1998 to 2001 using time-lapse infrared videocameras to identify nest predators. They recorded 59 predator visits (where at least some of the nest contents were removed or destroyed), resulting in 48 depredated nests. Snakes and fire ants (Solenopsis spp.) were the leading predators, accounting for 18 (38%) and 15 (31%), respectively, of all depredated nests. They also identified a variety of avian (19% of depredated nests) and mammalian predators (11% of depredated nests). Despite intensive brown-headed cowbird (Molothrus ater) removal at Fort Hood, nine predator visits by females of this species were recorded, but only one resulted in nest failure. Although predator visits occurred at all hours, most (58%) took place at night. The daily predation rate was higher during the nestling stage than during incubation, partly due to the apparent inability of fire ants to prey upon vireo eggs.

DISEASE: The species is unusually free of ectoparasites and disease (Graber 1961).

FORT HOOD: Studies of disease and ectoparasites have not been conducted on the black-capped vireo on Fort Hood.

Threats to Survival

Major threats to the continued existence of the black-capped vireo include (1) loss of habitat due to urban development, excessive rangeland improvement, grazing by sheep, goats, and exotic herbivores, and natural succession including juniper invasion; and (2) cowbird brood parasitism (Grzybowski 1995, Shull 1986, Ratzlaff 1987). The black-capped vireo recovery plan (USFWS 1991) and the 1995 Population Viability and Habitat Analysis (PVHA) Workshop Report (USFWS 1996) document regional threats to survival.

FORT HOOD: At Fort Hood, the primary threats to the black-capped vireo are brood parasitism, habitat loss and degradation, and fire suppression.

Croton alabamensis (Texabama croton)

No federally endangered or threatened plant species are known to occur on Fort Hood. The Alabama croton (*Croton alabamensis* var. *alabamensis*) is a species of concern that was formerly a category 2 candidate for federal listing. This species was formerly known from only two counties in Alabama and one county in Tennessee. In 1989 a variety of *C. alabamensis* was discovered on Fort Hood. This variety has subsequently been described and designated as *C. alabamensis* var. *texensis* (Ginzbarg 1992). It is sometimes known by the unofficial common name of Texabama croton.

Nomenclature and Classification

Scientific Name: Croton *alabamensis* var. *texensis*
Family: Euphorbiacae
Original Description: Ginzbarg 1992
Type Specimen: Gainer Ranch, Travis County, Texas, (Ginzbarg 1992).
Current Federal Status: Species of Concern

History of the Taxon

Alabama: *C. alabamensis* was first noticed by E.A. Smith in 1877 (McDaniel 1981), and has since been described as one of the rarest shrubs in the United States (Farmer and Thomas 1969). Habitat information and the original description were published in Mohr (1889). The Alabama variety of this taxon presently is listed as a category 2 candidate species for federal listing.

Texas and Fort Hood: In 1989, a disjunct population of this species was discovered on Fort Hood Military Reservation by John Cornelius, a Fort Hood installation wildlife biologist. Other Texas populations have subsequently been discovered in Travis and Coryell counties. After taxonomic review, the Texas population of this species was designated a new variety, *C. alabamensis texensis* (Ginzbarg 1992).

Description

Texas and Fort Hood: A technical description of the Texas variety of *C. alabamensis* is given in Ginzbarg, 1992. In most respects, the appearance of the Texas variety is very similar to the Alabama variety (described in Kral 1983). There are distinct differences in coloration of scales on the underside of the leaves and stems. The Texabama croton has copper-colored scale surfaces, and some scales have dark reddish-brown centers. In contrast, the Alabama variety has silver scale surfaces and scales lack dark centers.

The Texabama croton is a monoecious shrub 2-3 m tall with many branches emerging from the base. Lower branches sometimes take root and stems have thin gray bark, which gives a slightly sweet odor when scratched. Stems are leafy only near their tips and new growth is angular. Leaves are alternate, exstipulate; petioles 0.6-1.9 mm long, canaliculate; blades ovate or elliptic, 3.8-9.0 cm long, 1.5-4.0 cm wide, entire; apex acute, rounded or emarginate; base obtuse to slightly cordate, glandless; upper surface dark green with scattered scales. The inflorescence is a terminal 6-14 flowered raceme, 1.9-3.3 cm long with pistillate flowers near the base and staminate flowers above (Ginzbarg 1992).

Geographic Distribution and Known Population

Alabama: Prior to its discovery in Texas, *C. alabamensis* was known only from Tuscaloosa and Bibb Counties in Alabama and Coffee County in Tennessee (Ginzbarg 1992). In Alabama, the species is restricted to two major population centers. Individual populations consist of a few to many individuals covering several acres (Kral 1983). At the time of Farmer's work (1962), the species covered no more than about 40 ha.

Texas and Fort Hood: The Texas variety has been observed in Bell, Coryell and Travis Counties. In Travis County, the plants occur mostly in deciduous forest in mesic limestone canyons and on slopes. The major known populations in Travis County are on the Gainer Ranch (500-1,000 plants) and the Penn Ranch (several thousand individuals) (Ginzbarg 1992).

In Coryell County, the Texas variety is known only from Fort Hood. Both significant populations on Fort Hood occur in protected canyons along the Owl Creek river drainage in Land Groups 1 and 2 (Aplet et al. 1991). The largest population, consisting of several thousand individuals, occurs in Land Group 1 (Ginzbarg 1992). Several scattered plants and a small population have been found between and around these two populations near tributaries to Owl Creek (Aplet et al. 1991). The total population on Fort Hood is estimated to be around 20,000 individuals (Aplet et al. 1991).

Habitat

Alabama: There are pronounced differences between the habitat of the two croton varieties. The Alabama variety occurs on shallow soils and rock outcrops at mid-slope positions, and occurs in areas with intense drought and high soil and air temperatures. The croton groves in Alabama have few or no large trees, are dominated by shrubs, and have relatively few herbs (Farmer 1962).

Texas and Fort Hood: The Texas variety grows on shallow, moderately alkaline, gravelly or stony clay or clay-loam overlying Cretaceous limestone (Ginzbarg 1992). This variety forms dense local thickets as understory shrubs in mesic canyon hardwood forests or in full sun. The bark is thin and populations are generally confined to more mesic areas near streams and in canyons. However, populations were observed regenerating from root sprouts after fires in 1996.

Aplet et al. (1991) report that on Fort Hood, this croton variety grows in deep soils on toe slopes and fluvial deposits of canyon bottoms and is thus a drought avoider. They indicate that its occurrence exhibits no association with overstory gaps, disturbance, or particular fluvial geomorphic features. It appears to be restricted to canyon bottoms characterized by mesic conditions provided by the presence of overstory cover and a number of other species. Steeper stream gradients may produce microhabitat that is not conducive to establishment and growth.

Reproductive Biology

Alabama: The reproductive biology of the Alabama variety was evaluated by Farmer (1962). He observed no evidence of asexual reproduction, although the species has been propagated by stem cuttings. In nature, plants require five to seven years growth prior to onset of sexual reproduction. Flower buds are produced in May or June and overwinter before flowering in mid-March. Plants are self-fertile, with pistillate flowers often most numerous toward the bottom of the plant. Wind is the primary pollination agent. Fruits develop by mid-May. Seeds are dispersed up to about seven meters from the parent by a catapulting mechanism. A heavy seed crop is produced each year, much of it lost to rodents, birds, and possibly ants. Partial shade can reduce seed production by 10 to 50 percent. Forest cover can reduce it by 75 to 95 percent. Seeds, which require cold stratification, are dormant until germination takes place in February or March.

Texas and Fort Hood: Relatively little has been published about the reproductive biology of the Texas variety. Ginzbarg (1992) reports that it flowers from February - March, sets fruit in May, and fruits have dehisced by early June. In contrast to the Alabama variety, Aplet et al. (1991) reported good evidence of asexual reproduction. This involved the production of "new upright shoots through the nodal rooting (layering) of prostrate branches."

Survival and Growth

Alabama: The survival and growth in the Alabama variety have been fairly well studied. Seed survival is probably very low, perhaps one percent of seed production (Farmer 1962). Seedling mortality may be quite high as well. In experimental populations, Farmer (1962) reported 20 percent survival to two years. Clonal stands are all-aged and consist of individuals as old as 21 years (Farmer 1962). Following germination, seedlings grow until dormancy begins in June in Alabama (Farmer 1962). Most consistent plant growth occurs during March and April. More erratic growth occurs during periods of high moisture. Leaves turn yellow by mid-June. Growth of primary roots is restricted largely to the first two centimeters, with the remainder of root growth within 15 cm even on deeper soils.

Texas and Fort Hood: Aplet et al. (1991) reported that all size and age classes of the Texas variety are well represented on Fort Hood, indicating a healthy population of adults, juveniles, and new recruits. Little else has been reported about the survival and growth of the Texas variety.

Interactions with Other Species

Alabama: Other plant species characteristically found in association with the Alabama variety include golden St. Johnswort, skunkbush sumac, and red cedar with sumac usually most abundant (Farmer 1962). Seeds are thought to be utilized by various rodents, birds, and perhaps ants (Farmer 1962).

Texas and Fort Hood: On Fort Hood, species associated with the Texabama croton occur in the Texas Oak Series mesic limestone canyon forest community (Diamond 1992, Ginzbarg 1992). There is some indication that high cover of Texas ashe and Chinquapin oak indicates a good site for this croton variety (Aplet et al. 1991).

The dominant plant species observed where this variety is found on Fort Hood include ashe juniper (accounting for 53.6 percent of total cover), Texas ash (24.1 percent), Texas oak (23.7 percent), and a grape species (15.9 percent). Other relatively common species include Chinquapin oak (9.8 percent), Indian-cherry buckthorn (7.4 percent), Deciduous holly (7.2 percent), Cedar elm (6.1 percent), a walnut species (4.1 percent), and Lowland hackberry (3.04 percent) (Aplet et al. 1991). Within the two canyons in which it occurred, understory cover of the Texabama croton averaged 10.4 percent (Aplet et al. 1991).

Cave-adapted Fauna

Troglobite faunal communities of Texas (cave-adapted organisms) are often represented by rare endemics due to the narrow ecological niche and natural isolation of the cave systems they inhabit. The objective of this ESMP is to provide adequate protective measures to avoid listing cave-adapted species found on Fort Hood under the Endangered Species Act. Several endemic and currently undescribed cave invertebrate species and one probable new subspecies of salamander (*Plethodon* albagula) occur on Fort Hood.

A series of cave and karst investigations at Fort Hood have found at least seventeen species of troglobite or possible troglobite endemic to Fort Hood (Reddell and Veni 2004), of these, four species are probably new:

Spiders:
Cicurina (Cicurella) caliga Cokendolpher and Reddell
Cicurina (Cicurella) coryelli Gertsch
Cicurina (Cicurella) hoodensis Cokendolpher and Reddell
Cicurina (Cicurella) mixmaster Cokendolpher and Reddell
Cicurina (Cicurella) troglobia Cokendolpher
Neoleptoneta paraconcinna Cokendolpher and Reddell

Pseudoscorpions:
Tartarocreagris hoodensis Muchmore

Centipedes
Gosibius (Abatobius) new species

Millipedes:
Speodesmus castellanus Elliott

Silverfish:
Texoreddellia probable new species

Ground beetles:
Rhadine reyesi Reddell and Cokendolpher

Ant-like litter beetles:
Batrisodes (Babnormodes) new species no. 1
Batrisodes (Babnormodes) new species no. 2
Batrisodes (Babnormodes) new species no. 3
Batrisodes (Babnormodes) feminiclypeus Chandler and Reddell
Batrisodes (Babnormodes) gravesi Chandler and Reddell
Batrisodes (Babnormodes) wartoni Chandlere and Reddell

Nomenclature and Classification

Species 1.
Scientific Name: *Cicurina* (*Cicurella*) *caliga*
Family: Dictynidae
Original Description: Cokendolpher and Reddell (2001)
Type Specimen: The female holotype is from Triple J Cave, Nov. 1994 (collected by M. Warton) and is deposited in the American Museum of Natural History. The following paratypes were designated: two females from Triple J Cave, 13 June 2000 (collected by J. Krejca, J. Reddell, M. Reyes, P. Sprouse) and deposited in the Texas Memorial Museum; one female from Triple J Cave, 14 June 2000 (collected by J. Krejca, J. Reddell, M. Reyes, P. Sprouse), and retained in the collection of James C. Cokendolpher; one female from Buchanan Cave, 5 May 1999 (collected by J. Reddell, M. Reyes), and deposited in the Texas Memorial Museum; one female from Streak Cave, 13 June 2000 (collected by J. Krejca, J. Reddell, M. Reyes, P. Sprouse), and deposited in the Texas Memorial Museum.
Current Federal Status: Species of Concern

Species 2.
Scientific Name: Cicurina (Cicurella) coryelli
Family: Dictynidae
Original Description: Gertsch (1992)
Type Specimen: The female holotype is from Tippit Cave, 31 Jan. 1992 (J. Reddell, M. Reyes), and is in the American Museum of Natural History.
Current Federal Status: Species of Concern

Species 3.
Scientific Name: Cicurina (Cicurella) hoodensis
Family: Dictynidae
Original Description: Cokendolpher and Reddell (2001)
Type Specimen: Female holotype from Buchanan Cave, 7 May 1998 (L.J. Graves, J. Reddell, M. Reyes), deposited in the American Museum of Natural History. The following paratypes have been designated: 2 females paratypes from Buchanan Cave, 7 May 1998 (L.J. Graves, J. Reddell, M. Reyes), 1 in the Texas Memorial Museum, 1 in the James C. Cokendolpher collection; 3 female paratypes from Buchanan Cave (4 Nov. 1998 (J. Cokendolpher, J. Krejca, J. Reddell, M. Reyes), in the Texas Memorial Museum; 4 female paratypes from upper level of Buchanan Cave (13 June 2000 (J. Krejca, J. Reddell, M. Reyes, P. Sprouse), 3 in Texas Memorial Museum, 1 in James C. Cokendolpher collection; 1 female paratype from Camp 6 Cave No. 1, 20 April 1998 (L.J. Graves, J. Reddell, M. Reyes), in Texas Memorial Museum; 1 female paratype from Camp 6 Cave No. 1, 2 Nov. 1998 (J. Cokendolpher, J. Reddell), in Texas Memorial Museum; 1 female paratype from Peep in the Deep Cave, 3 Nov. 1998 (J. Cokendolpher, J. Reddell), in Texas Memorial Museum; 1 female paratype from Peep in the Deep Cave, 5 May 1999 (J. Reddell, M. Reyes), in Texas Memorial Museum; 1 female paratype from Talking Crows Cave, 2 Nov. 1998 (M. Reyes), in Texas Memorial Museum; 1 female

paratype from Treasure Cave, 2 Nov. 1998 (J. Cokendolpher, J. Reddell, M. Reyes), in Texas Memorial Museum.
Current Federal Status: Species of Concern

Species 4.
Scientific Name: Cicurina (Cicurella) mixmaster
Family: Dictynidae
Original Description: Cokendolpher and Reddell (2001).
Type Specimen: The female holotype is from Mixmaster Cave, 5 Nov. 1998 (J. Cokendolpher, J. Krejca, J. Reddell, M. Reyes), in American Museum of Natural History
Current Federal Status: Species of Concern

Species 5.
Scientific Name: *Cicurina* (*Cicurella*) *troglobia* new species
Family: Dictynidae
Original Description: Cokendolpher (in press).
Type Specimen: The female holotype is from Seven Mile Mountain Cave, 28 June 2000 (J. Reddell, M. Reyes), deposited in the American Museum of Natural History.
Current Federal Status: Species of Concern

Species 6.
Scientific Name: Neoleptoneta paraconcinna
Family: Leptonetidae
Original Description: Cokendolpher and Reddell (2001).
Type Specimen: The holotype male is from Peep in the Deep Cave, 21 April 1998 (J. Reddell, M. Reyes), in the American Museum of Natural History. The following paratypes have been designated: 1 female paratype from Peep in the Deep Cave, 21 April 1998 (J. Reddell, M. Reyes), in the Texas Memorial Museum; 1 male paratype from Camp 6 Cave No. 1, 5 May 1999 (J. Reddell, M. Reyes), in the Texas Memorial Museum; 1 female paratype from Figure 8 Cave, 20 April 1998 (L.J. Graves, J. Reddell, M. Reyes), in the Texas Memorial Museum.
Current Federal Status: Species of Concern

Species 7.
Scientific Name: Tartarocreagris hoodensis
Family:
Original Description: Munchmore (1999)
Type Specimen: Female holotype from Chigiouxs' Cave, 21 November 1995 (J. Reddell, M. Reyes), in Florida State Collection of Arthropods; allotype male from Buchanan Cave, 4 November 1998 (J.C. Cokendolpher, J. Krejca, J. Reddell, M. Reyes), in Florida State Collection of Arthropods; paratype female from Rugger's Rift Cave, 5 November 1998 (J. Reddell, M. Reyes), in Florida State Collection of Arthropods.
Current Federal Status: Species of Concern

Species 8.
Scientific Name: *Speodesmus castellanus* Elliott

Family: Fuhrmannodesmidae
Original Description: Elliott (in press).
Type Specimen: Male holotype from Rocket River Cave, 16 January 1992 (L.J.Graves, C. Savvas), deposited in the American Museum of Natural History. Male and female paratypes with same data also deposited in the American Museum of Natural History.
Current Federal Status: Species of Concern

Species 9.
Scientific Name: Texoreddellia
Family:
Original Description: Currently undescribed. Known only from two caves on Fort Hood.
Type Specimen: No type specimen exists.
Current Federal Status: Species of Concern

Species 10.
Scientific Name: Rhadine reyesi
Family: Carabidae
Original Description: Reddell and Cokendolpher (2001).
Type Specimen: Male holotype from Tippit Cave, 8 April 1999 (M. Reyes), in the American Museum of Natural History. The following paratypes have been designated: One paratype female from Tippit Cave, 8 April 1999 (M. Reyes), in the American Museum of Natural History; one paratype male from Tippit Cave, 8 April 1999 (M. Reyes), in the Texas Memorial Museum; one paratype male from Tippit Cave, 8 April 1999 (L.J. Graves), in the Texas Memorial Museum; one paratype male from Tippit Cave, 31 Jan. 1992 (J. Reddell, M. Reyes), in the Texas Memorial Museum; two paratype males from Tippit Cave, 9 Feb. 1992 (J. Reddell, M. Reyes), in the Texas Memorial Museum; three paratype males and three paratype females, 3 Nov. 1992 (J. Reddell, M. Reyes), in the Texas Memorial Museum; one paratype female, 6 Nov. 1992 (J. Reddell, M. Reyes), in the Texas Memorial Museum; one paratype male and one paratype female, 16 July 1993 (D. McKenzie, J. Reddell, M. Reyes), in the University of Texas A&M.
Current Federal Status: Species of Concern

Species 11.
Scientific Name: Batrisodes (Babnormodes)
Family: Staphylinidae
Original Description: Species is undescribed. Only known to exist in 1 cave on Ft. Hood.
Type Specimen: None exists.
Current Federal Status: Species of Concern

Species 12.
Scientific Name: Batrisodes (Babnormodes) feminiclypeus
Family: Staphylinidae
Original Description: Chandler and Reddell (2001)
Type Specimen: Male holotype from Skeeter Cave, 18 May 1999 (L.J. Graves, J.

Reddell, M. Reyes), in the Field Museum of Natural History. The following paratypes have been designated: one male, three males from Skeeter Cave, 18 May 1999 (L.J. Graves, J. Reddell, M. Reyes), in the Texas Memorial Museum.
Current Federal Status: Species of Concern

Species 13.
Scientific Name: Batrisodes (Babnormodes) gravesi
Family: Staphylinidae
Original Description: Chandler and Reddell
Type Specimen: Holotype male from Streak Cave, 26 Sept. 1997 (L.J. Graves, J. Reddell, M. Reyes), in Field Museum of Natural History. The following paratypes have been designated: four females from Streak Cave, 6 Oct. 1995 (M. Warton); one female from Buchanan Cave, 7 May 1998 (L.J. Graves, J. Reddell, M. Reyes); one male from Bumelia Well Cave, 28 Oct. 1994 (D. Allen, D. Love); 1 male from Bumelia Well Cave, 4 Nov. 1998 (J. Cokendolpher, J. Krejca, J. Reddell, M. Reyes); 1 male from Figure 8 Cave, 9 Feb. 1996 (M. Warton); 1 female from Lucky Rock Cave, 10 Sept. 1997 (L.J. Graves, J. Reddell, M. Reyes); 1 male from Price Pit Cave, 6 May 1999 (J. Reddell, M. Reyes); 1 female from Triple J Cave, 4 Oct. 1995 (M. Warton); 3 males from Triple J Cave, 23 April 1998 (L.J. Graves, J. Reddell, M. Reyes); 1 female from Keyhole Cave, 6 May 1999 (J. Reddell, M. Reyes); 1 female from Mixmaster Cave, 5 Nov. 1998 (J. Cokendolpher, J. Krejca, J. Reddell, M. Reyes.).
Current Federal Status: Species of Concern

Species 14.
Scientific Name: Batrisodes (Babnormodes) wartoni
Family: Staphylinidae
Original Description: Chandler and Reddell (2001)
Type Specimen: Holotype male from Rocket River Cave, 27 Oct. 1994 (M. Warton), in Field Museum of Natural History. The following paratypes have been designated: 1 female from Chigiouxs' Cave, 21 Nov. 1995 (J. Reddell, M. Reyes); 2 females from Tippit Cave, 9 Feb. 1992 (J. Reddell, M. Reyes); 1 male from Tippit Cave, 31 Jan. 1992 (J. Reddell, M. Reyes); 1 female from Tippit Cave, 3 Nov. 1992 (J. Reddell, M. Reyes); 1 female from Tippit Cave, 6 Nov. 1992 (J. Reddell, M. Reyes); three females from Tippit Cave, 1 July 1993 (D. McKenzie, J. Reddell, M. Reyes).
Current Federal Status: Species of Concern

Population Estimates

Due to their inaccessibility, rarity, and often secretive nature, population estimates are not available (Reddell and Veni 2004). Additionally, long periods of drought and similar conditions effect the ability to consistently detect many of these species presence.

Geographic Distribution

None of the species of concern considered for this plan are known to occur outside of Fort Hood (Reddell and Veni 2004). The primary source of information on the distribution of the species of concern at Fort Hood is a previous report (Reddell, 2002).

Threats to Survival

Cave invertebrates typically are found in moist caves with constant humidity and temperature (USFWS 1994). Caves occupied by endangered invertebrates in Travis and Williamson Counties, Texas, are small and as shallow as three meters. Species associated with these caves were listed primarily to mitigate threats due to increasing urbanization. The largest has only 60 m of passage (Chambers and Jahrsdoerfer 1988). The cave fauna depends on surface water infiltration. If caves become dry during certain periods of the year, the resident fauna may retreat to deeper, inaccessible parts of the system. Troglobites are entirely dependent upon surface organisms and other troglobites and troglophiles for their energy and nutrients (USFWS 1994). Fort Hood has numerous cave and karst features, and the associated invertebrates are vulnerable to military activities.

Based on proposed species as identified by USFWS (1998), Rendell and Veni (2004) identified the following factors as potential threats to cave fauna:

1. Construction: No construction has occurred outside of the cantonment area, however this could change. Such activities in karst areas could destroy or lead to the pollution of cave environments.

2. Soil Erosion: Erosion can alter the food chain, impact drainage or completely fill in and eliminate cave habitat. Fifteen caves containing karst invertebrates are impacted by erosion. Many additional sinks are filled in from erosion.

3. Water Quality: Toxicological studies have not been conducted on water borne contaminants on the karst invertebrates. However, adverse impacts of a wide variety of organic chemicals, heavy metals, and other contaminants on other organisms suggest probable harmful effects on karst species. Potential sources of contamination include vehicle fuel/oil spills, and residues from explosives and other ordinance.

4. Training Activity: Filling in of cave features by close proximity vehicle traffic represents a likely threat to karst habitat. Additionally, trash left from troop activity has historically been found in caves and sinks.

5. Predation: Red imported fire ants are abundant on Fort Hood and could pose a threat. Taylor et.al. (2003) studied six caves on Ft. Hood. They reported no findings of mass infestations of caves; however, did find evidence of foraging trails inside caves.

Refer to Reddell and Veni (2004) for a detailed listing of the above threats.

Salamander (Plethodon albagula.)

In addition to the previous 17 species, specimens of the probable new salamander subspecies (*Plethodon albagula)* have been collected from caves in the northeast training ranges of Fort Hood. These new specimens are currently undergoing taxonomic review to determine species status. This subspecies is presumably not cave-restricted and has a limited geographical range. Taylor and Phillips (2003) provide data and this species distribution and morphological measurements on Fort Hood. Taylor and Phillips (2002) failed to show a relationship between the presence/absence of plethodon based on fire ants. However their results were not conclusive.

Other Species

Additional listed species occur either as accidental or as transients on Fort Hood (Table 1). For some of these species detailed management plans are not warranted at this time due to infrequent, transient occurrence on the installation. Only species discussed briefly below are considered further in this ESMP.

Bald Eagle

The bald eagle has been recorded during winters at Belton Lake on or adjacent to Fort Hood (J. Cornelius, personal communication). The bald eagle does not nest on the installation.

Whooping Crane

The whooping crane also is a rare migrant. Five whooping cranes were sighted in Land Group 3 during December 1986. They may fly over or near Fort Hood during spring (1 to 20 April) and fall (1 to 20 October) migration (Diersing et al. 1985). They may stop at Belton Lake during migration.

Peregrine Falcon

Anecdotal observations of peregrine falcons have been recorded on Fort Hood. Peregrine falcons do not nest on the installation and observations are likely transitory migrants.

4. Conservation Actions: All Federally Listed Species

Objective 1

Regardless of habitat designation on Training Area maps, the Army will comply with all applicable sections of the Endangered Species Act (1973, as amended) for all training, operations, maintenance, and construction activities conducted on Fort Hood.

Objective Justification:

This ESMP does not supersede the legal obligation of the Army and Fort Hood to comply with Federal law as set forth in the Endangered Species Act (1973, as amended).

Conservation Actions:

As required by Section 7 of the Endangered Species Act, the Army and Fort Hood will assess the effect of any proposed activity on any listed species or its habitat occurring in the project area. Fort Hood has conducted a biological assessment for the current ongoing mission and the USFWS has issued a Biological Opinion (16 March 2005) that provides conditions for the continuance of mission activities on Fort Hood. Fort Hood currently is in compliance with conditions of the 2005 Biological Opinion. Some areas on Fort Hood are subject to training restrictions under the Fort Hood Endangered Species Training Guidelines (Appendix C) due to the presence of listed species and are designated on Fort Hood Training Area maps. Areas not subject to training restrictions under the Fort Hood Training Guidelines are still subject to all Section 7 compliance requirements and Terms and Conditions of the USFWS 2005 Biological Opinion.

Objective 2

Implement installation fire management and protection policies.

Objective Justification:

The objective of Fort Hood fire management policies on Fort Hood is to provide a balance among operational flexibility, endangered species habitat management requirements, and prevention of destructive wildfires. One objective of the Fort Hood fire management policy is to reduce downtime for training operations due to excessive fire control activities. Many training-related fires are of low risk to facilities, personnel or habitats of concern. In these cases a “let-burn” policy is warranted. Also black-capped vireo habitat requires some level of periodic disturbance to maintain optimal habitat conditions. Periodic fires in these habitats assists in maintaining these conditions. On the other hand, uncontrolled wildfires can pose a serious risk to range facilities, personnel and large areas of endangered species habitats as demonstrated by the extensive wildfires that occurred in February 1996.

Conservation Actions:

Implement fire-rating system and control procedures in accordance with Fort Hood OPLAN 8-93 "Operation Brush Fire" and Fort Hood Regulation 350-40.

Monitor effects of all fires on endangered species habitat occurring on the installation. Fort Hood will maintain records on the date and areas of endangered species habitat affected, and report these data annually to the Service.

Coordinate between the Fire Department and Natural Resource Management Branch during the decision to approve/disapprove Range Condition Red waivers.

Emphasize use of preventative prescribed fire to maintain blacklines near habitat areas annually. Employ firebreaks in association with endangered species habitats to reduce fire risk.

Maintain and upgrade fire-fighting capabilities including aerial support, subject to the availability of funds.

Continue research on the effects of the February 1996 wildfires.

Objective 3

Manage vegetation clearing projects to minimize fire hazard from slash, and avoid impacts to residual stands.

Objective Justification:

Vegetation clearing activities are conducted on Fort Hood for military range maintenance, habitat management and to reduce fire hazard. Vegetation removal potentially can increase erosion rates. The resulting slash from these activities poses a significant fire risk if not disposed of properly. If left in place, slash piles can impact survival of residual live vegetation. Proper disposal of slash is required to avoid these risks.

Conservation Actions:

Reduce fire hazard from juniper clearing, brush removal projects, construction of firebreaks, etc. by avoiding piling slash material around or against live trees and removing slash from the site or burning or mulching in place. Slash disposal methods will be included in the scope of proposed projects.

Where possible, mulch slash material on site rather than removal or burning, in order to return nutrients to the soil and reduce erosion.

As an integral part of project design, maximize the use of preventative measures to minimize soil loss after vegetation removal. Examples include re-seeding with native herbaceous plant seed, deferral of grazing from rehabilitation sites, placement of water bars on slopes, and using waste material in gullies as appropriate.

Coordinate all vegetation clearing with Natural Resources Management Branch from the planning phase forward in order to minimize or avoid impacts to endangered species and their habitat, and support overall objectives of the INRMP, of which the ESMP is a part.

Objective 4

Emphasize the use of prescribed burning to support protection and maintenance of endangered species habitat, and support ecosystem management principles.

Objective Justification:

Periodic disturbance is an important functional component of most natural systems. Natural disturbance typically supports enhanced biodiversity, nutrient cycling and habitats for many endangered species and species of concern. In central Texas, fire is the primary natural disturbance regime in upland habitats. During recent historical periods, fire suppression has resulted in juniper encroachment, loss of deciduous scrub habitats, and increases in invasive, non-native grasses and forbs. Prescribed burning provides land managers a tool to more nearly replicate pre-settlement landscape and habitat conditions on Fort Hood in support of endangered species management and ecosystem function.

Conservation Actions:

All prescribed burning must be overseen by Natural Resources Management Branch personnel certified and experienced in prescribed burning techniques, and support the overall objectives of the INRMP.

Develop a habitat regeneration/enhancement plan that is compatible with endangered species management and mission training requirements.

Identify areas suitable for maintenance as BCVI habitat and implement habitat management prescriptions as necessary.

Use prescribed fire to the maximum extent possible to reduce fuel loads near important areas.

Use prescribed fire to maintain prairie sites and to inhibit development of pure juniper stands. Fire should be considered as a low-cost, non-invasive means of avoiding future need for destructive large-scale mechanical clearing projects.

Objective 5

Evaluate factors affecting endangered species productivity, survival and habitats.

Objective Justification:

Several non-specific threats to endangered species populations occur on Fort Hood. These threats include direct and indirect effects due to imported fire ants and feral hog populations. Control of these non-native species will benefit a broad range of natural resource components on the installation including endangered species populations.

Conservation Actions:

Investigate species-selective methods, including hot water injection methods, for control of imported fire ants in endangered species habitat and near important karst features.

Continue to control feral hog population utilizing aerial support and trapping, and evaluate effectiveness of control methods.

Objective 6

Monitor the quality and quantity of available endangered species habitat.

Objective Justification:

Allowable incidental take and reduction in training restrictions under the Fort Hood Biological Opinion (16 March 2005) is contingent on availability and maintenance of suitable habitat to support viable endangered species populations on the installation. Meeting this objective requires adequate information on the current and future status of habitats on the installation and adequate oversight to ensure compliance with installation regulations on allowable activities within endangered species habitats.

Conservation Actions:

Continue use of helicopter over-flights as needed to ensure compliance with training guidelines, monitor effects of training activity in endangered species habitat, and monitor oak wilt centers.

Evaluate habitat trends based on change detection imagery every five years.

Maintain adequate natural resource law enforcement presence to effectively monitor land use, and enforce training guidelines and off-road vehicle restrictions.

Refine mapping efforts to enhance endangered species information management on Fort Hood.

Objective 7

Maintain and distribute Training Area maps with overlay of areas subject to Fort Hood Endangered Species Training Guidelines (Fig. 2, Appendix A).

Objective Justification:

Soldiers performing field training must have access to current maps showing designated restricted areas in order to comply with requirements of the Fort Hood Endangered Species Training Guidelines (Appendix C). Conservation actions to meet this objective will ensure to the extent possible that all soldiers and commanders on Fort Hood have access to current information on the location of restricted areas.

Conservation Actions:

Training Area maps will be revised to show areas in the maneuver training ranges subject to conditions of the Fort Hood Endangered Species Training Guidelines in accordance with habitat designations established under this ESMP. Areas subject to the Endangered Species Training Guidelines on maneuver training areas will be labeled as “Training Restricted Zones” on training area maps.

Revised Training Area maps will be issued or available to all applicable installation commands and training support elements. All earlier editions will be collected and destroyed to the extent possible.

Training Area maps will be revised every five years concurrent with the 5-year revision of this ESMP to incorporate any changes in designated habitats subject to training restrictions.

5. Conservation Actions: Golden-cheeked Warbler

Objective 1

Maintain sufficient habitat to support a minimum carrying capacity of 2000 singing males

Objective Justification:

Population viability analyses indicate that habitat carrying capacity lower than that necessary to support a maximum of 1000 singing males of golden-cheeked warblers greatly increases the probability of extinction (Hayden et al. 2001). Increasing carrying capacities above 1000 singing males does not significantly alter the probability of extinction. Carrying capacity represents the *maximum* potential of the habitat to support singing males. Carrying capacity does not necessarily reflect the number of singing males normally expected to occur. However, increases in carrying capacity above 1000 singing males does increase the expected number of singing males present. Maintaining carrying capacity in excess of 1000 singing males also provides some buffer in the event of catastrophic loss of habitat or birds. A carrying capacity of 2000 exceeds the threshold for increased extinction risk and provides capacity for the presence of substantial numbers of singing males in excess of current USFWS recovery goals.

Conservation Actions:

PVA analysis for Fort Hood indicates a minimum of 8520 ha (21,641 ac) of habitat is necessary to provide a carrying capacity for 2000 singing males. Current estimate of available habitat on Fort Hood is 21,422 ha (54,412 ac). Under current assumptions and parameter estimates of the PVA, enough habitat currently exists on Fort Hood to meet this objective. The Conservation Action to meet this objective will be to minimize any loss of warbler habitat on Fort Hood due to fire, training, or other habitat altering activities in accordance with protection and management objectives established under this ESMP.

Objective 2

Implement training restrictions in designated "core" habitats in accordance with Fort Hood Endangered Species Training Guidelines).

Objective Justification:

Military training in areas occupied by golden-cheeked warblers can destroy habitat and disturb individuals, potentially resulting in reduced abundance and productivity. These impacts increase the possibility of "take" as defined in the ESA. The Fort Hood Biological Opinion (16 March 2005) states that implementation of the Fort Hood Training Guidelines in golden-cheeked warbler habitat will assist in minimizing effects of incidental take related to military training activities. "Core" habitat areas designated under this objective were selected based on known population distributions, quality and contiguity of habitat, and minimal mission conflicts.

Conservation Actions:

Implement Fort Hood Endangered Species Training Guidelines for 3861 ha (9807 ac) of golden-cheeked warbler habitat designated as “core” habitats (Fig. 2).

Provide orientation and training for appropriate personnel on the implementation of the guidelines.

The Fort Hood Natural Resources Branch will maintain records and maps of all areas occupied by endangered species including both non-core and core habitats designated under the Fort Hood Endangered Species Training Guidelines.

“Non-core” habitat areas will remain subject to all other applicable Fort Hood range regulations, in particular regulations governing activities that could result in permanent alteration to endangered species habitat. An example would be the requirement to submit for approval Excavation Permit #420-X10 prior to initiating any excavation activities on the installation.

Objective 3

Implement a sustainable incidental take limit for the five-year term of this ESMP.

Objective Justification:

The intent of this ESMP is to promote recovery of endangered species on Fort Hood lands while permitting the military maximum flexibility to perform mission essential tasks. Current estimates of available golden-cheeked warbler habitat on Fort Hood exceed population and recovery goals under this ESMP. Implementation of incidental take limits provides flexibility for conducting mission activities that may result in habitat loss. However, this potential habitat loss is limited so as not to jeopardize baseline habitat requirements and to provide an adequate habitat mitigation bank in perpetuity without implementing further restrictive measures on the military mission. Habitat “loss” as defined under this ESMP is any permanent or temporary alteration of currently suitable habitat to the extent that it is unsuitable for occupation by breeding adults.

Conservation Actions:

Maintain habitat loss due to training activities over the next five-year period below the 660 ha (1676 ac) and 125 nests limits established under the Fort Hood Biological Opinion (16 March 2005).

Maintain habitat loss due to construction and range improvements over the next five-year period below the 217 ha (551 ac) limit established under the Fort Hood Biological

Opinion (16 March 2005).

Any loss of habitat or nests considered incidental take will be reported on an annual basis to the installation Commander and to the USFWS as part of the installation's annual reporting requirement.

Objective 4

Maintain currently available habitat consistent with population carrying capacity goal and essential mission requirements.

Objective Justification:

Fort Hood currently provides sufficient habitat to meet population carrying capacity goals under this ESMP and to exceed USFWS recovery objectives. Limited opportunities exist to further increase habitat availability. Maintenance of these habitats in excess of USFWS recovery goals will promote the long-term survival of the species, which is in the interest of the Army and Fort Hood to achieve greater training flexibility.

Conservation Actions:

Develop and maintain a current map of oak wilt centers, with particular emphasis on training areas where core endangered species habitat occurs.

Identify and prioritize oak wilt centers which threaten, or may potentially threaten, core habitat.

Investigate treatment and/or isolation methods which might be feasible to limit oak wilt effects.

Implement appropriate oak-wilt control measures based on priority evaluation.

If fungal mats are identified on trees that necessitate removal of that tree during the breeding season, a representative of the Natural Resource Management Branch will be present to ensure that the tree is not being directly utilized by the GCWA as a nesting site. Every effort will be taken to avoid or minimize a direct impact to listed species as a result of management for oak wilt.

Investigate the effects of oak wilt on GCWA habitat.

Prohibit the use of motorized off-road recreational vehicles in endangered species habitat.

Objective 5

Document golden-cheeked warbler population trend and factors affecting population status.

Objective Justification:

Population change is the base-line measure of conservation success and recovery for the population. This measure is necessary to differentiate between normal annual variability and true trends in populations over time. Evaluation of factors affecting populations allows and determination of population change due to natural or stochastic processes versus change due to human land use practices.

Conservation Actions:

Document population trends and assess population status of the golden-cheeked warbler.

Evaluate the effects of de-designation of Core Habitat on golden-cheeked warbler demography and productivity.

Evaluate the relationship between habitat quality and golden-cheeked warbler abundance and productivity.

Evaluate fire-related dispersal patterns of golden-cheeked warblers.

Continue to allow safe access to training and Live-Fire Areas for golden-cheeked warbler surveys during the period of March 15 through July 31 to ensure that equivalent data is collected for study areas both in and out of the Live Fire Area. It is important that the integrity of data collected from existing golden-cheeked warbler productivity, predation and population trend studies is maintained.

Continue to generate color sequences for range-wide color banding of golden-cheeked warblers through cooperation with the Service.

Investigate the dispersal of golden-cheeked warblers from Fort Hood to surrounding areas through cooperative studies with other researchers and at Corps of Engineers property at Lake Belton and Stillhouse Hollow Lake.

Conduct point count censuses on a minimum of 318 points to obtain numbers of birds detected per location per observer, annually.

Determine numbers of singing males within designated intensive study areas, annually.

Conduct the following activities annually in each of the intensive study areas:

- Band all adults possible with a unique combination of leg bands.
- Locate and monitor active nests to the extent possible.
- Search for returning, banded birds.
- Band juveniles (HY).

Monitor the following demographic and reproductive parameters annually in all intensive study areas:

- Banding status of all birds observed.
- Presence or absence of a female on each male territory.
- Territory size.
- Number of young with each adult.
- For all nests located; number of host and parasite eggs, nestlings, fledglings, and nest fate.
- Distance from banding location to resighting location in subsequent years.
- As time permits, search areas throughout the installation where birds have been banded in the past for returning birds including returning HY.

6. Conservation Actions: Black-capped Vireo

Objective 1

Maintain sufficient habitat to support a minimum carrying capacity of 1000 singing males.

Objective Justification:

Population viability analyses indicate that habitat carrying capacity lower than that necessary to support a maximum of 1000 singing males of black-capped vireos greatly increases the probability of extinction (Hayden et al. 2001). Increasing carrying capacities above 1000 singing males does not significantly alter the probability of extinction. Carrying capacity represents the *maximum* potential of the habitat to support singing males. Carrying capacity does not necessarily reflect the number of singing males normally expected to occur. A population carrying capacity goal in excess of 1000 singing males would not significantly lower extinction probability or significantly increase expected number of individuals. A population carrying capacity goal of 1000 singing males meets USFWS recovery objectives for this species.

Conservation Actions:

PVA analysis for Fort Hood indicates a minimum of 4170 ha (10,592 ac) of black-capped vireo habitat is necessary to provide a carrying capacity for 1000 singing males (Hayden et al. 2001). Current estimate of available habitat on Fort Hood is 6967 ha (17,719 ac). Under current assumptions and parameter estimates of the PVA, enough habitat currently exists on Fort Hood to meet this objective. The Conservation Action to meet this objective will be to minimize any loss of black-capped vireo habitat on Fort Hood due to fire, training, or other habitat altering activities in accordance with protection and management objectives established under this ESMP.

Objective 2

Implement a sustainable incidental take limit for the five-year term of this ESMP.

Objective Justification:

The intent of this ESMP is to promote recovery of endangered species on Fort Hood lands while permitting the military maximum flexibility to perform mission essential tasks. Current estimates of available black-capped vireo habitat on Fort Hood exceed population and recovery goals under this ESMP. Implementation of incidental take limits provides flexibility for conducting mission activities that may result in habitat loss. However, this potential habitat loss is limited so as not to jeopardize baseline habitat requirements and to provide an adequate habitat mitigation bank in perpetuity without implementing further restrictive measures on the military mission. Habitat “loss” as defined under this ESMP is any permanent or temporary alteration of currently suitable habitat to the extent that it is unsuitable for occupation by breeding adults.

Conservation Actions:

Maintain habitat loss due to training activities over the next five-year period below the 360 ha (914 ac) and 150 nests limits established under the Fort Hood Biological Opinion (16 March 2005).

Maintain habitat loss due to construction and range improvements over the next five-year period below the 108 ha (274 ac) limit established under the Fort Hood Biological Opinion (16 March 2005).

Any loss of habitat or nests considered incidental take will be reported on an annual basis to the installation Commander and to the USFWS as part of the installation's annual reporting requirement.

Objective 3

Maintain sufficient habitat to meet population goal in seral stage suitable for occupation by black-capped vireos.

Objective Justification:

Typically, vireos on Fort Hood are observed in early successional habitat resulting from burns or mechanical clearing of vegetation in areas with suitable soils and geologic substrate. Currently, 6967 ha (17,696 ac) have been identified as suitable vireo habitat. Due to the ephemeral nature of habitat in these areas targeted for habitat management, restoration must be implemented to replace areas where vegetation has succeeded beyond the stage preferred by vireos. This objective maintains at least the current level of vireo habitat on Fort Hood.

Conservation Actions:

Identify areas suitable for maintenance as black-capped vireo habitat and implement habitat management prescriptions as necessary.

Develop a habitat regeneration/enhancement plan that is compatible with endangered species management and mission training requirements.

Objective 4

Maintain parasitism of vireo nests by brown-headed cowbirds below an average of 10 percent annually in non-live-fire training areas during the five-year term of this ESMP.

Objective Justification:

Cowbird parasitism reduces reproductive success of black-capped vireos on Fort Hood (Tazik 1992, Hayden et al. 2000). Analyses by Tazik (1991) of the effect of cowbird parasitism on vireo productivity indicate that incidence of cowbird parasitism must be below 25 percent to maintain stable or increasing vireo populations. A target goal of average annual parasitism below 10 percent was determined because of effectiveness of historical control efforts and to be consistent with thresholds established by the USFWS under other agreements. Since 1992, cowbird control efforts have maintained parasitism levels in non-live-fire areas below 10 percent on Fort Hood. Also, USFWS has established a 10 percent parasitism threshold in provisions of a Memorandum of Understanding with Central Texas Cattleman's Association regarding grazing leases on Fort Hood. Maintaining parasitism levels below an average of 10 percent annually will enhance vireo reproductive success on Fort Hood and support achievement of population objectives. Reducing cowbird parasitism is the only management technique currently available to directly affect reproductive success.

Conservation Actions:

Remove a sufficient number of female cowbirds during the peak vireo breeding months, March-June, to maintain parasitism levels below an annual average of 10 percent for all non-live-fire training areas for the five-year term of this ESMP. Trap effort will be conducted at levels sufficient to maintain parasitism levels below the 10 percent annual target.

Shooting will be conducted within selected occupied vireo habitats where high levels of cowbird parasitism have been documented despite trapping effort.

Cowbird trapping during the months July-February will be conducted to reduce resident adult cowbird populations, reduce juvenile female abundance, reduce vandalism damage, and provide year-round presence and awareness among troops training in the field.

Develop and implement, pending USFWS approval, a controlled field study to evaluate modification of the current installation cowbird control program. The purpose of this study will be to evaluate parasitism rates in response to reducing trapping efforts in selected regions of Fort Hood compared with areas where control efforts are maintained. If necessary, the proposed study will request exemption from the 10 percent threshold level for parasitism rates for the duration of the study.

Objective 5

Document black-capped vireo population trend and factors affecting population status.

Objective Justification:

Population change is the base-line measure of conservation success and recovery for the population. This measure is necessary to differentiate between normal annual variability and true trends in populations over time. Evaluation of factors affecting populations allows and determination of population change due to natural or stochastic processes versus change due to human land use practices.

Conservation Actions:

Document population trends and assess population status of the black-capped vireo.

Evaluate the effects on black-capped vireo demography and productivity of the reduction of habitat area designated as Core Habitat.

Continue to allow safe access to training and Live-Fire Areas for black-capped vireo surveys during the period of March 15 through July 31 to ensure that equivalent data is collected for study areas both in and out of the Live Fire Area. It is important that the integrity of data collected from existing black-capped vireo productivity, predation and population trend studies is maintained.

Continue to generate color sequences for range-wide color banding of black-capped vireos through cooperation with the Service.

Investigate the dispersal of black-capped vireos from Fort Hood to surrounding areas through cooperative studies with other researchers and at Corps of Engineers property at Lake Belton and Stillhouse Hollow Lake.

Determine numbers of singing males within each intensive study areas, annually.

As time permits, visit all known and suspected sites of vireo occupation to document distribution of black-capped vireos on Fort Hood.

Conduct the following actions annually in each intensive study areas:

- Monitor all territories in each intensive study area throughout the vireo breeding season.
- Monitor at least 40 territories in the live-fire zone with representation from each of five "Endangered Species Study Areas (ESSA)." Endangered Species Study Areas within the live-fire zone are designated by agreement between the installation Fish and Wildlife Branch and G3. Normally, this monitoring requirement will require access to each ESSA approximately once every two weeks during the breeding season. This requirement will minimize conflict with ongoing training by maximum use of weekend training holidays, range maintenance periods, and other training downtime through coordination with G3.
- Locate and monitor all located nests on monitored territories.
- Band all adults, juveniles, and nestlings to the extent possible.

Monitor the following demographic and reproductive parameters for all monitored territories:

- Banding status of all birds observed.
- Presence or absence of a female on each male territory.
- Territory size.
- Number of young with each adult.
- For all nests located; number of host and parasite eggs, nestlings, fledglings, and nest fate.
- Distance from banding location to resighting location in subsequent years.
- Monitor successional development of habitat and vireo colonization in areas burned during the February 1996 fire.

6. Conservation Actions: Croton alabamensis

Objective 1

Protect known locations from human-related disturbance.

Objective Justification:

Protection of known locations of croton populations from human-related disturbance is a proactive approach to mitigate impacts and possibly prevent listing of species as threatened or endangered. Known populations are in locations where virtually no military training is conducted.

Conservation Actions:

No additional action is required at this time. No land use activities that may disturb croton populations are known to occur in these areas. Natural Resource Branch land managers will review protection status for these areas if potential threats occur from future land use activities.

Objective 2

Monitor status and distribution of populations.

Objective Justification:

Monitoring croton population trends will provide managers with information necessary to decide whether additional protection or management actions are required to maintain viable croton populations.

Conservation Actions:

Visit known locations annually to visually assess condition of known populations.

7. Conservation Actions: Cave-adapted Fauna

Objective 1

Protect sensitive cave and karst features from human-related risk factors identified in the 2004 "Management Plan for the Conservation of Rare Karst Species on Fort Hood, Bell and Coryell Counties, Texas."

Objective Justification:

Human activities and changes to surrounding habitats are the greatest threat to cave-adapted fauna. Protection of cave features from these impacts is a proactive approach to mitigate potential impacts and possibly prevent listing of species potentially eligible for threatened or endangered status.

Conservation Actions:

Gates have been placed at entrances to caves that have been identified as particularly sensitive and susceptible to human disturbance. The following actions should be followed to construct and maintain gates for sensitive cave and karst features:

- Inspect all current cave gates annually and perform any necessary maintenance.
- Identify any additional cave or karst features susceptible to human disturbance and determine if gates would alleviate potential problems. Fund and implement construction of additional gates if appropriate.

In the vicinity of cave and karst features where military training increases risk of vegetation destruction and sedimentation, buffer zones should be implemented by placing signs or other barriers at sufficient distance from cave entrances to minimize disturbance.

Objective 2

Locate, map, and conduct biological collections in sensitive cave and karst features on Fort Hood.

Objective Justification:

This objective will meet requirement of the ESA to determine presence of listed species and will identify potential for conflicts with mission and land use activities on Fort Hood.

Conservation Actions:

Conduct biological collections in known cave and karst features if such collections have not previously been performed or are incomplete.

Locate and survey cave and karst features in areas subject to military training or other land use activities which would potentially result in disturbance of these features.

Objective 3

Develop management plan for the new salamander species, Plethodon spp.

Objective Justification:

Development of a comprehensive management plan for this new salamander species will reduce the potential listing of this species due to threats to its environment or populations.

Conservation Actions:

Develop management plan based on known distributions, risk factors and implications for mission activities.

Objective 4

Complete taxonomic evaluation and description of undescribed material collected from Fort Hood caves.

Objective Justification:

This work is necessary to identify a new species potentially eligible for listing or species that are currently listed as endangered.

Conservation Actions:

Submit taxonomic findings to USFWS for status review.

8. Conservation Actions: Other Species

Objective 1

Whooping Crane: If *whooping cranes are observed, protect from potential disturbance by military training and other land use activities.*

Objective Justification:

The ESA requires protection from harassment for all listed species. Whooping crane presence on the installation is likely to be highly transitory during migration. For this reason no specific protection plan appears warranted at this time. However, activity of transient individuals should be monitored to prevent potential disturbance from human activity.

Conservation Actions:

Monitor activity of whooping cranes while present on the installation.

Notify G3, Range Control and other appropriate training and operations organizational elements of any potential training disturbance in proximity to observed individuals.

Suspend training activities in proximity to whooping cranes until they have departed installation lands.

Objective 2

Bald Eagle: *Minimize disturbance from low-level helicopter flights and other aviation assets.*

Objective Justification:

The ESA requires protection from harassment for all listed species. Low-level aircraft flights can disturb wintering populations of this species occurring near Belton Lake.

Conservation Actions:

When bald eagles are first observed in autumn, notify the Fort Hood air-space coordinator, and implement the no-fly zone. This zone is situated on and near Belton Lake in parts of Land Groups 2 and 3. Flight restrictions will be lifted when no bald eagles have been observed for a period of two weeks.

Objective 3

Peregrine Falcon: *If peregrine falcons are observed, monitor presence for potential disturbance from human activity.*

Objective Justification:

The Peregrine Falcon was delisted in 1999. the ESA requires monitoring five years after delisting. Peregrine falcon presence on the installation in likely to be highly transitory during migration and not associated with any particular physical feature of the installation as in the case for whooping cranes and bald eagles (i.e. Belton Lake). For these reasons no specific protection plan appears warranted at this time. However, activity of transient individuals should be monitored to prevent potential disturbance from human activity.

Conservation Actions:

Monitor activity of peregrine falcons while present on the installation.

Objective 4

Conduct surveys to determine presence and status of other listed, rare and sensitive species.

Objective Justification:

The ESA requires Federal agencies to document the presence of and assess effects of land use activities on any species occurring on Fort Hood lands that may be eligible or proposed for listing in the future. Documentation of these species' presence and status will meet ESA requirements and is proactive approach to avoiding project conflicts in the future. The preferred outcome is to identify and implement necessary management actions to avoid listing of species under the ESA.

Conservation Actions:

Installation biologists will review species listed in Table 1 annually and will revise and amend as appropriate.

Based on the installation review above, surveys will be initiated as necessary to document presence and status of listed, rare, or sensitive species on the installation.

Results of these surveys will be kept on record by the Fort Hood Natural Resources Branch and submitted to the USFWS.

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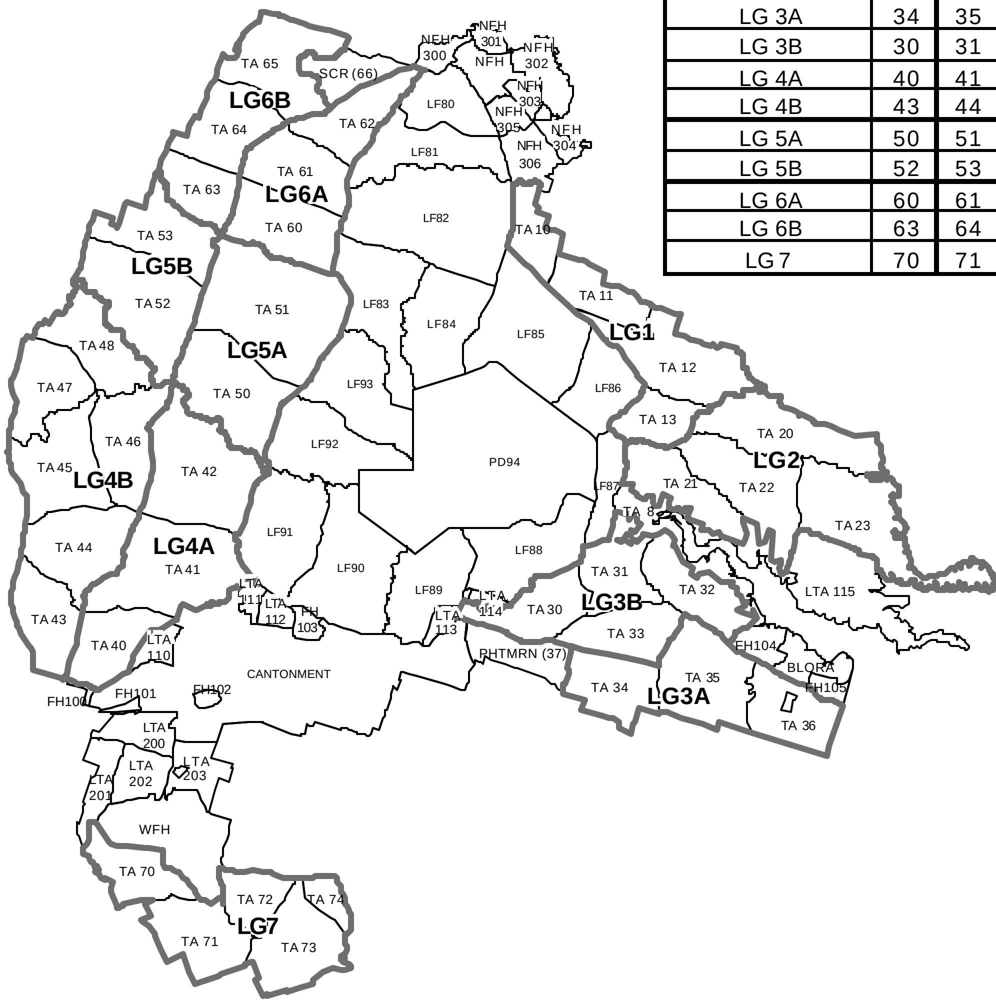
Table 1. Federal endangered, threatened, candidate species and species of concern that occur or may occur on Fort Hood. There are several endemic cave invertebrates and a salamander species found on Fort Hood that may eventually become candidate or listed species (see text).

Common Name	**Scientific Name**	**Listing Status**[a]	**Status**[b]
FEDERALLY LISTED SPECIES			
Crane, whooping	*Grus americana*	E	B
Bald eagle	*Haliaeetus leucocephalus*	T	B
Vireo, black-capped	*Vireo atricapilla*	E	A
Warbler, golden-cheeked	*Dendroica chrysoparia*	E	A
CANDIDATE SPECIES			
Salado salamander	*Eurycea chisholmensis*	C	C
Smalleye shiner	*Notropis buccula*	C	C
SPECIES OF CONCERN			
Peregrine falcon	*Falco peregrinus anatum*	N/A	B
Texabama croton	*Croton alabamensis*	N/A	A
Salamander (new species)	Under taxonomic review	N/A	A
Cave invertebrates	See Text	N/A	A

[a] Federal listing status; E=endangered, T=threatened, C=candidate[b] Status refers to population status on Fort Hood according to these definitions: (A) Population established on Fort Hood. Recent information documents an established breeding population (even if small) or regular occurrence, on the installation. This includes those species for which research and management is on-going and several endemic cave invertebrates. (B) Recently recorded on Fort Hood, but there is no evidence of an established population. This includes species considered to be transient, accidental, or migratory (e.g., some migrating birds may use the installation as a stopover site during migration to and from

their wintering grounds). For some species in this category, further inventory may reveal breeding populations. (C) Not known to occur on Fort Hood. These species are not considered further in this ESMP.



LAND GROUP (LG)	TRAINING AREAS (TA)					
LG 1	10	11	12	13		
LG 2	20	21	22	23		
LG 3A	34	35	36			
LG 3B	30	31	32	33		
LG 4A	40	41	42			
LG 4B	43	44	45	46	47	48
LG 5A	50	51				
LG 5B	52	53				
LG 6A	60	61	62			
LG 6B	63	64	65			
LG 7	70	71	72	73	74	

Figure 1. Training Area designations for Fort Hood, Texas. PD = permanently dudded area. LF = live-fire ranges. WFH = West Fort Hood. BLORA = Belton Lake Outdoor Recreation Area.

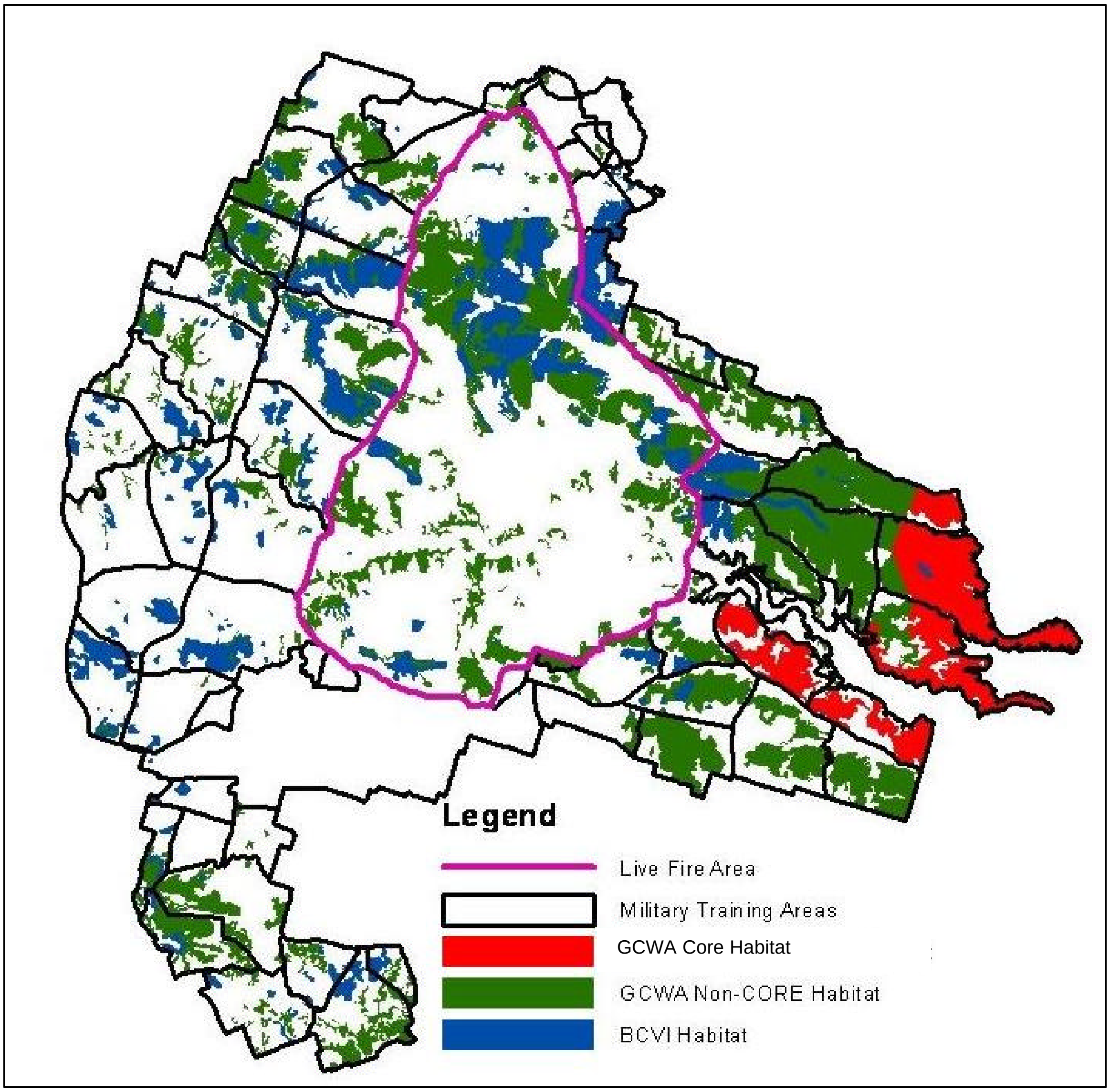


Figure 2. Golden-cheeked warbler and black-capped vireo habitats on Fort Hood, Texas.

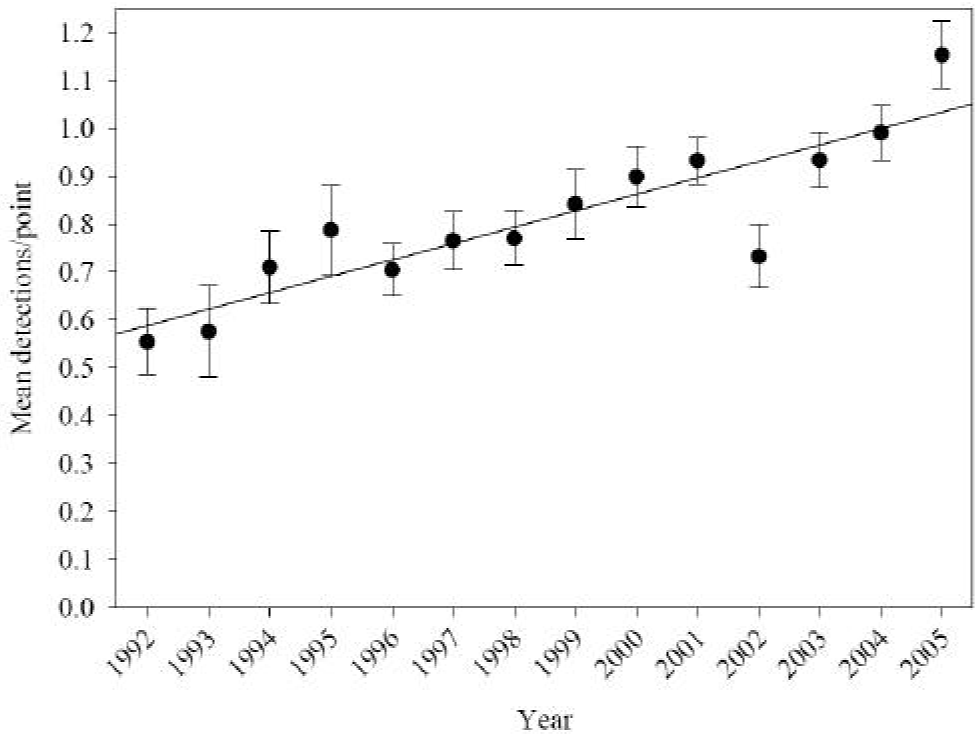


Figure 3. Mean detections/point/year of the golden-cheeked warbler increased during 1992–2005 on Fort Hood Military Reservation, Texas, USA (Peak 2005b).

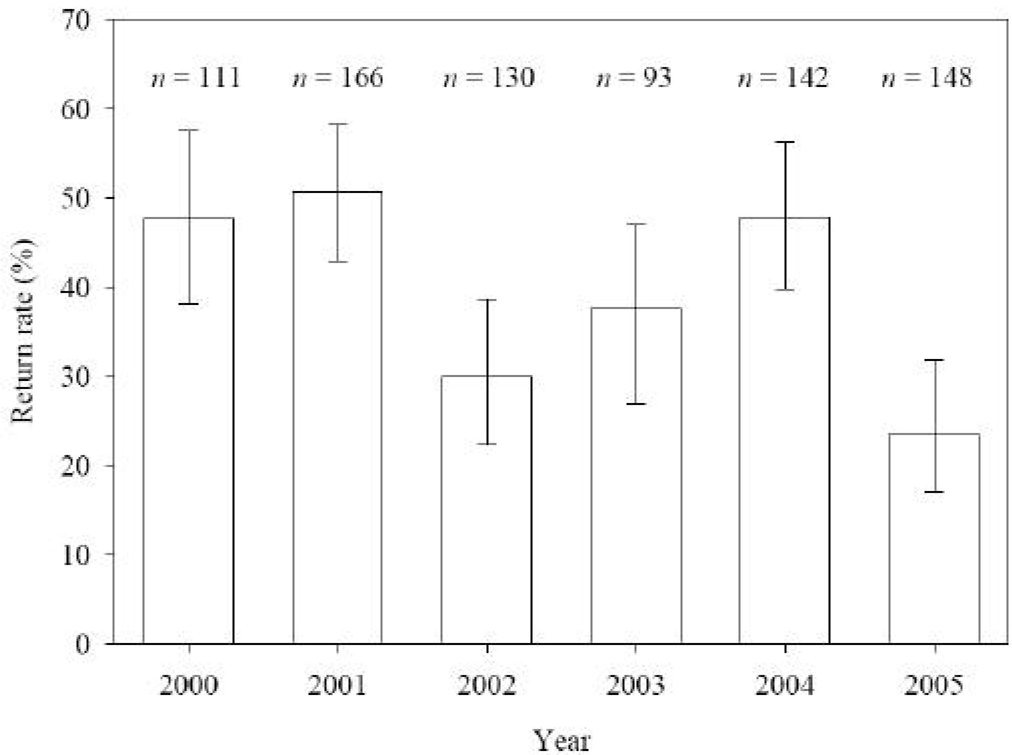


Figure 4. Return rate of male golden-cheeked warblers (mean ± 95% confidence interval) differed among 2000–2005 on Fort Hood (Peak 2005b).

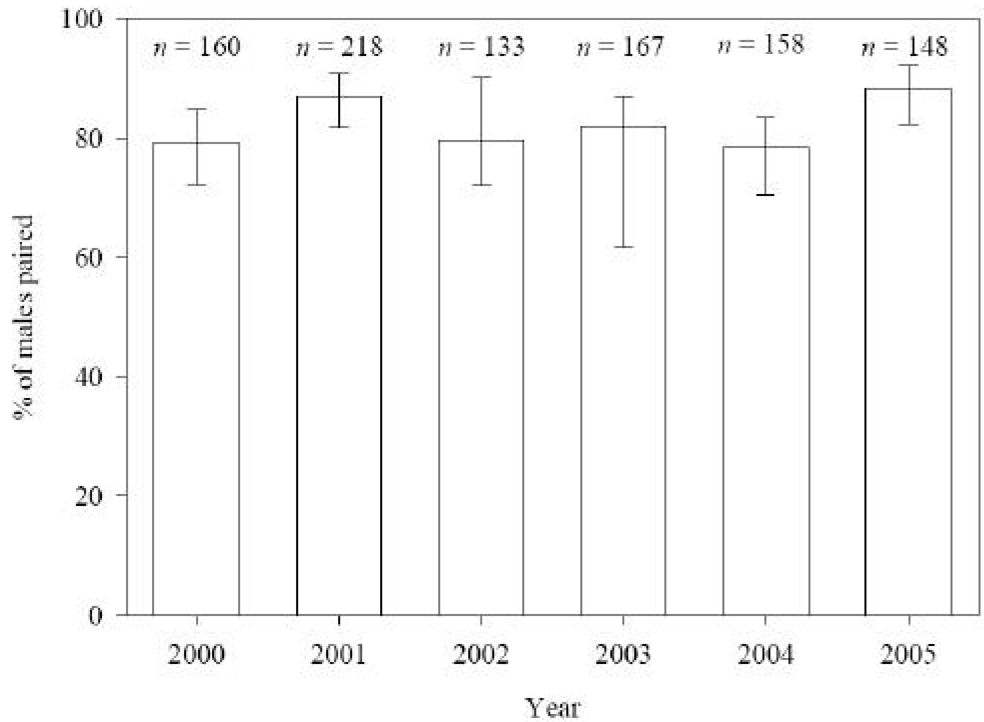


Figure 5. Pairing success for territorial male golden-cheeked warblers (mean ± 95% confidence interval) did not differ among 2000–2005 on Fort Hood (Peak 2005b).

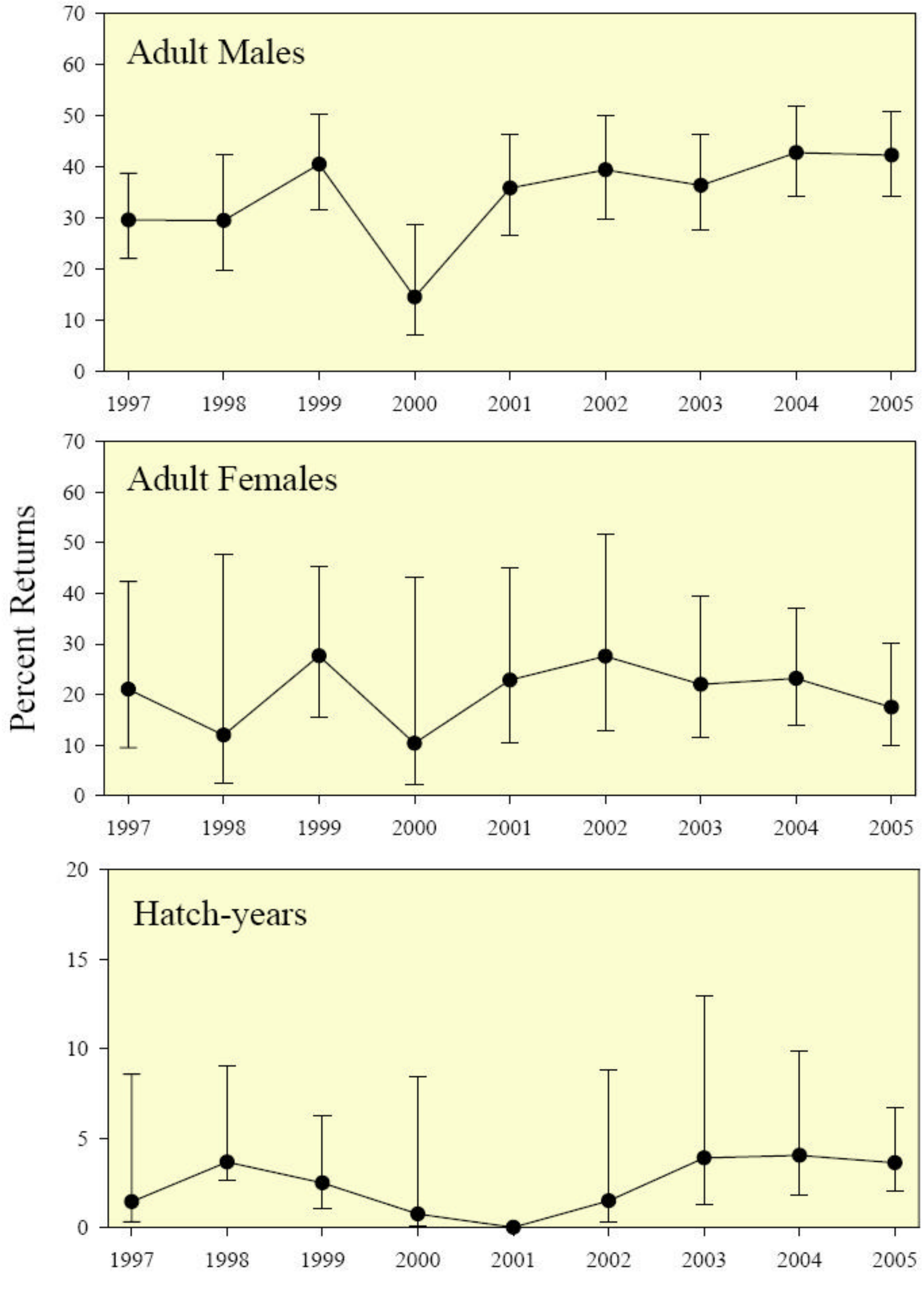


Figure 6. Return rates of banded black-capped vireos to study areas on Fort Hood, Texas from 1997 to 2005. Each point represents the percentage of individuals present the previous year that were detected in the current year on the same study area. The vertical lines span 95% confidence intervals. Note that the y-axis scale on the graph representing hatch-year birds differs from the scale on the other two graphs (Cimprich 2005).

APPENDIX A

Fort Hood Biological Opinion, 16 March 2005

APPENDIX F

Fish Species at Fort Hood

Native Fish Species of Fort Hood

SCIENTIFIC NAME:	COMMON NAME:
Aplodinotus grunniens	Freshwater Drum
Dorosoma cepedianum	Gizzard Shad
Dorosoma petenense	Threadfin Shad
Campostoma anamalum	Central Stoneroller
Carpoides carpio	River Carpsucker
Cyprinum carpio	Common Carp
Notemigonus crysoleucas	Golden Shiner
Notropis buchanani	Ghost Shiner
Cyprinella lutrensis	Red Shiner
Cyprinella venustus	Blacktail Shiner
Pimephales vigilax	Bullhead Minnow
Ameiurus melas	Black Bullhead
Ameiurus natalis	Yellow Bullhead
Ictalurus punctatus	Channel Catfish
Pylodictus olivaris	Flathead Catfish
Fundulus notatus	Blackstripe Topminnow
Gambusia affinis	Mosquitofish
Menidia beryllina	Tidewater Silverside
Lepisosteus osseus	Longnose Gar
Lepomis auritus	Redbreast Sunfish
Lepomis cyanellus	Green Sunfish
Lepomis humilis	Orangespotted Sunfish
Lepomis macrochirus	Bluegill
Lepomis megalotis	Longear Sunfish
Lepomis microlophus	Redear Sunfish
Lepomis punctatus	Spotted Sunfish
Lepomis gulosus	Warmouth
Micropterus punctulatus	Spotted Bass
Micropterus salmoides	Largemouth Bass
Moxostoma congestum	Gray Redhorse
Pomoxis annularis	White Crappie
Etheostoma spectabile	Orangethroat Darter
Percina caprodes	Logperch
Percina carbonaria	Texas Logperch
Percina sciera	Dusky Darter

APPENDIX G

Bird Species at Fort Hood

BIRDS OF FORT HOOD, TEXAS: CHECKLIST AND SEASONAL DISTRIBUTION

Compiled by Rich Kostecke, David Cimprich, and Mike Stake

Fort Hood, a 219,000 acre military installation, is situated within Bell and Coryell counties along the border of the Edwards Plateau and Crosstimbers and Southern Tallgrass Prairie ecoregions in central Texas. To date, 291 species have been documented on Fort Hood. Monthly abundances are based on the number of individuals of a species that are likely to be seen during a typical birding visit to Fort Hood.

This checklist only represents our *current* knowledge of the occurrence and abundance of birds on Fort Hood. Much remains to be learned about the Fort Hood avifauna. Several expected species have not yet been documented on Fort Hood or during expected months. Additionally, sightings have been biased towards shrublands and mature Ashe juniper-oak woodlands where research on the endangered Black-capped Vireo and Golden-cheeked Warbler is conducted during March through July. Other habitats (e.g., grasslands, riparian woodlands, and wetlands) and times of year (e.g., fall and winter) have received less attention.

Since this checklist is a work in progress, we would appreciate receiving any information on the occurrence and abundance of birds on Fort Hood. In particular, data on arrival and departure dates of migrant species; species which are currently designated as rare, very rare, casual, or accidental; evidence of breeding; new records for a given month; new species for the checklist; unusual (low or high) numbers; and the like would be greatly appreciated. Please forward such information to:

Rich Kostecke
The Nature Conservancy of Texas
PO Box 5190
Fort Hood, TX 76544-0190
(254) 288-2088
rkostecke@tnc.org

ABUNDANCE CODES

A	Abundant: >100/day **usually seen daily** in appropriate habitat
C	Common: 25–100/day **usually seen daily** in appropriate habitat
FC	Fairly Common: 10–25/day **usually seen daily** in appropriate habitat
U	Uncommon: 1–10/day; **usually seen daily** in appropriate habitat
R	Rare: typically 1–5/day and 1–10/month; **usually not seen daily**
VR	Very Rare: 10–40 records for the month
Ca	Casual: 4–10 records for the month
X	Accidental: 1–3 records for the month
*	Has bred on base at least once or is suspected to breed on base
**	Regular breeder

SPECIES	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Waterfowl												
Greater White-frntd Goose		X										
Snow Goose	X								X			
Canada Goose				X							X	
Wood Duck**	R	FC	R	R	R	R	R	R	R	R	R	R
Gadwall	U	U	U	R					R	R	R	R
American Wigeon	U	R							R	U	U	U
Mallard	R	FC	R	R					R	R	R	R
Blue-winged Teal			FC	C	U			FC	C			
Cinnamon Teal				X								
Northern Shoveler			R	R								
Northern Pintail		FC							R	FC		
Green-winged Teal		C							R	U		
Canvasback		R									R	
Redhead		A	A	R							C	
Ring-necked Duck	U	U	U	R							FC	U
Greater Scaup	X											
Lesser Scaup	C	C	C	C							C	C
Hooded Merganser											X	
Ruddy Duck	U	U	U	FC							U	FC
Turkey & Quail												
Wild Turkey**	U	U	U	U	U	U	U	U	U	U	U	U
Northern Bobwhite**	R	R	R	U	U	U	U	U	R	R	R	R
Loons & Grebes												
Pied-billed Grebe	U	U	U	R	X	X	X		U	U	U	U
Horned Grebe			X									
Red-necked Grebe				X								
Pelicans & Cormorants												
American White Pelican			FC	A	C	X						
Brown Pelican							X					
Neotropic Cormorant			X	X	CA	X						
Double-crested Cormorant	FC	FC	C	C	U				R	C	FC	FC
Herons												
Great Blue Heron**	U	U	U	U	U	U	U	U	U	U	U	U
Great Egret				FC	R	R	R	U	FC	R		
Snowy Egret				U				FC	U			
Little Blue Heron				U	R	R						
Tricolored Heron							X	Ca				
Cattle Egret			FC	C	FC	X			FC	U		
Green Heron**				R	U	U	U	U	U			
Yellow-crwnd Night-heron					R	R	R					

SPECIES	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Ibises & Spoonbills												
Roseate Spoonbill								X				
Vultures												
Black Vulture**	U	U	U	FC	U	U	U	FC	U	U	U	U
Turkey Vulture**	C	C	C	C	C	C	C	C	C	C	C	C
Kites, Hawks & Eagles												
Osprey*	R	R	R	U	R	R	R	R	R	R	R	R
Swallow-tailed Kite					X							
Mississipi Kite				U	U							
Northern Harrier	U	U	U	R	R						U	U
Bald Eagle	R			X								R
Sharp-shinned Hawk	R	R	R	R	VR	Ca	Ca	Ca		R	R	R
Cooper's Hawk*	R	R	R	R	R	R	R	Ca		R	R	R
Red-shouldered Hawk**	R	R	R	R	R	R	R	R	R	R	R	R
Broad-winged Hawk				R	R	X	X				X	
Swainson's Hawk*			Ca	R	R	R	R	R	R	FC		
Zone-tailed Hawk					X							
Red-tailed Hawk**	U	U	U	U	U	U	U	U	U	U	U	U
Ferruginous Hawk				X								
Golden Eagle								X				
Falcons												
Crested Caracara*	R	R	R	R	R	R	R	R	R	R	R	R
American Kestrel	U	U	U	U	Ca		X	X	U	FC	U	U
Merlin			Ca	Ca								
Peregrine Falcon				R	X							
Prairie Falcon			X	X								
Rails & Cranes												
King Rail					X							
American Coot	C	C	C	A	R	Ca	Ca		FC	C	C	C
Sandhill Crane	X	Ca	A								R	Ca
Whooping Crane											X	
Shorebirds												
American Golden-plover				X								
Snowy Plover									X			
Semipalmated Plover									X			
Killdeer**	U	U	FC	FC	U	U	U	FC	FC	U	U	U
Black-necked Stilt								Ca				
American Avocet								Ca				
Greater Yellowlegs			R	R	X		R	R	R	R	R	
Lesser Yellowlegs				R	X				R			
Solitary Sandpiper				R					U			
Willet							X	X	X			

SPECIES	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Spotted Sandpiper				U	U		R	U	U	U	R	
Upland Sandpiper			R	U	U	R						
Long-billed Curlew			X			X	X		X			
Marbled Godwit									X			
Red Knot					X							
Western Sandpiper									X			
Least Sandpiper			R	R	R				FC			
White-rumped Sandpiper					X	X						
Baird's Sandpiper				R					U			
Pectoral Sandpiper					R			FC	R			
Stilt Sandpiper									X			
Long-billed Dowitcher									R			
Wilson's Snipe			R	U	R				R	R		
American Woodcock	X	X			X							X
Wilson's Phalarope				X	X				X			
Gulls & Terns												
Franklin's Gull				FC	U							
Laughing Gull				X								
Bonaparte's Gull	U	U	U	R								U
Ring-billed Gull	FC	FC	FC	U						U	U	U
Herring Gull	R										R	R
Forster's Tern	C	C	C	C	FC					R	FC	C
Black Tern					X							
Pigeons & Doves												
Rock Pigeon**	C	C	C	C	C	C	C	C	C	C	C	C
Eurasian Collared-dove**	R	R	R	R	R	R	R	R	R	R	R	R
White-winged Dove**	C	C	C	C	C	C	C	C	C	C	C	C
Mourning Dove**	C	C	C	C	C	C	C	C	C	C	C	C
Inca Dove**	R	R	R	R	R	R	R	R	R	R	R	R
Common Ground-dove**				VR	R	R	R					
Cuckoos												
Black-billed Cuckoo					Ca							
Yellow-billed Cuckoo**				R	FC	U	U	U	U			
Greater Roadrunner**	U	U	U	U	U	U	U	U	U	U	U	U
Groove-billed Ani				X	X							
Owls												
Eastern Screech-owl**	R	R	R	R	R	R	R	R	R	R	R	R
Great Horned Owl**	R	R	R	R	R	R	R	R	R	R	R	R
Burrowing Owl	R	R	R								R	R
Barred Owl*				X	Ca	X						
Long-eared Owl					X							
Short-eared Owl											X	

SPECIES	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Nightjars & Swifts												
Common Nighthawk**				R	FC	FC	FC	FC	R			
Common Poorwill*			X	X	Ca						X	
Chucks-will's-widow**				U	U	U	U					
Chimney Swift**			Ca	R	U	U	U	U	U	R		
Hummingbirds												
Ruby-thrtd Hummingbird*			X	VR	VR		X	X	R			
Blck-chinned Hummingbird**			R	U	U	U	U	X				
Broad-tailed Hummingbird				X								
Kingfishers												
Belted Kingfisher**	U	U	U	U	R	R	R	R	U	U	U	U
Woodpeckers												
Golden-fronted Woodpecker					Ca	X	X					
Red-bellied Woodpecker**	U	U	U	U	U	U	U	U	U	U	U	U
Yellow-bellied Sapsucker			R							R		
Ladder-bckd Woodpecker**	U	U	U	U	U	U	U	U	U	U	U	U
Downy Woodpecker**	U	U	U	U	U	U	U	U	U	U	U	U
Hairy Woodpecker					X	X						
Northern Flicker	R	R	R	Ca	X	X	X			U	R	R
Flycatchers												
Olive-sided Flycatcher					U	X						
Eastern Wood-pewee*				R	U	R	R	R				
Empidonax species				R	U	X						
Yellow-bellied Flycatcher					R	X	X	Ca				
Acadian Flycatcher*				X	VR	Ca	X	X				
Traill's Flycatcher					R	Ca	Ca	Ca				
Alder Flycatcher					R							
Willow Flycatcher					R							
Least Flycatcher				R	U		VR	VR	R			
Eastern Phoebe*	U	U	U	U	R	R	R	R	R	U	U	U
Say's Phoebe				X								
Vermilion Flycatcher*				X	X	X						
Ash-throated Flycatcher**			R	U	U	U	U	X				
Great-crested Flycatcher**				U	U	U	U	R				
Great Kiskadee						X						
Western Kingbird**				U	FC	FC	FC					
Eastern Kingbird*				R	U	X						
Scissor-tailed Flycatcher**			U	FC	FC	FC	FC	FC	C	U	U	
Shrikes												
Loggerhead Shrike**	U	U	U	U	U	U	U	U	U	U	U	U
Vireos												
White-eyed Vireo**			C	C	C	C	C	C	U			

SPECIES	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Bell's Vireo**				U	U	U	U					
Black-capped Vireo**			U	FC	FC	FC	FC	U	R	X		
Yellow-Throated Vireo*					R	R	R					
Blue-headed Vireo			X	R	R	R			R			
Warbling Vireo				R	R				R			
Philadelphia Vireo					X							
Red-eyed Vireo**				U	U	U	U	U	U			
Jays & Crows												
Blue Jay**	U	U	U	U	U	U	U	U	U	U	U	U
Western Scrub-jay**	U	U	U	U	U	U	U	U	U	U	U	U
American Crow**	C	C	FC	FC	FC	FC	FC	FC	FC	C	C	C
Common Raven?				Ca	X	X						
Larks												
Horned Lark*	A	A	A	U	U	U	U	U	U	A	A	A
Swallows												
Purple Martin**		R	R	R	R	R	R					
Tree Swallow*			R	R	R	R						
N Rough-winged Swallow**			R	R	R	R	R					
Bank Swallow*					R							
Cliff Swallow**			C	A	A	A	A	A				
Cave Swallow**		R	U	U	U	U	U	U	U			
Barn Swallow**			U	U	U	U	U	U	FC	C		
Titmice & Chickadees												
Carolina Chickadee**	FC	FC	FC	FC	FC	FC	FC	FC	FC	FC	FC	FC
Tufted Titmouse							X					
Black-crested Titmouse**	FC	FC	FC	FC	FC	FC	FC	FC	FC	FC	FC	FC
Bushtit, Nuthatches & Creepers												
Bushtit					X	X						
Red-breasted Nuthatch			X	VR	Ca							
Brown Creeper				Ca	Ca							
Wrens												
Rock Wren						X						
Canyon Wren**	U	U	U	U	U	U	U	U	U	U	U	U
Carolina Wren**	FC	FC	FC	FC	FC	FC	FC	FC	FC	FC	FC	FC
Bewick's Wren**	FC	FC	FC	FC	FC	FC	FC	FC	FC	FC	FC	FC
House Wren			R	U	R				R	R		
Marsh Wren					X							
Kinglets & Gnatcatchers												
Ruby-crowned Kinglet	U	U	FC	U	R				U	U	U	U
Golden-crowned Kinglet	R	R	R	Ca							R	R
Blue-gray Gnatcatcher**			C	C	C	C	FC	U	U			

SPECIES	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Bluebirds												
Eastern Bluebird**	FC	FC	FC	U	U	U	FC	U	U	FC	FC	FC
Mountain Bluebird	X											X
Mimic Thrushes												
Gray Catbird*		X	X	R	U	X	X					
Northern Mockingbird**	FC	FC	FC	FC	FC	FC	FC	FC	FC	FC	FC	FC
Brown Thrasher*			U	U	R					U		
Curve-billed Thrasher				X	X							
Thrushes												
Swainson's Thrush			X	R	R							
Gray-cheeked Thrush					X							
Hermit Thrush			R	R	X						R	
Wood Thrush				X	X							
American Robin*	C	C	C	R	Ca	Ca	Ca			R	C	C
Townsend's Solitaire			X									
Starlings												
European Starling**	C	C	C	C	C	C	C	C	C	C	C	C
Pipits												
American Pipit	C	C	C	U	X					U	C	C
Sprague's Pipit			X						X			
Waxwings												
Cedar Waxwing	C	C	C	C	C	X					C	C
Warblers												
Tennessee Warbler				R	R	X						
Orange-crowned Warbler	U	U	U	FC	R					U	U	U
Nashville Warbler			R	U	U	X	X		U	U		
Northern Parula				R	R		X					
Yellow Warbler				R	U			U	U			
Chestnut-sided Warbler				R	R							
Magnolia Warbler				R	R	X						
Yellow-rumped Warbler	U	U	FC	C	R					U	U	U
Golden-cheeked Warbler**			FC	FC	FC	U	R					
Blck-thrtd Green Warbler			R	R	VR					R		
Blackburnian Warbler					R							
Palm Warbler				X								
Pine Warbler												X
Bay-breasted Warbler				X								
Prairie Warbler			X									
Blackpoll Warbler					X							
Cerulean Warbler				X								
Black-and-white Warbler**			U	U	U	R	R	Ca				
American Redstart					R							

SPECIES	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Prothonotary Warbler*				R	R	R	R					
Ovenbird					R							
Louisiana Waterthrush*				R	R		R		R			
Mourning Warbler					R							
MacGillivray's Warbler					X							
Common Yellowthroat				R	R	R			U	U		
Hooded Warbler			X	X	X							
Wilson's Warbler					R				R			
Canada Warbler				R	R							
Yellow-breasted Chat**				U	U	U	U					
Tanagers												
Summer Tanager**				U	U	U	U	U	U			
Scarlet Tanager			X	X		X						
Sparrows												
Spotted Towhee	U	U	FC	FC	R	Ca	X			U	U	U
Eastern Towhee			R	R	Ca	X						
Canyon Towhee				X	Ca	X						
Cassin's Sparrow*				Ca	VR	VR	X					
Rufous-crowned Sparrow**	U	U	U	U	U	U	U	U	U	U	U	U
Chipping Sparrow	U	U	FC	U	U		X			C	U	U
Clay-colored Sparrow				R	R							
Field Sparrow**	FC	FC	FC	FC	U	U	U	U	U	U	FC	FC
Vesper Sparrow	U	FC	U	R	Ca					R	U	U
Lark Sparrow**			U	FC	FC	FC	C	FC	U	U	U	
Lark Bunting					X	X						
Savannah Sparrow	FC	FC	FC	FC	R					U	U	FC
Grasshopper Sparrow**			U	FC	FC					R		
LeConte's Sparrow		R	R	X	X							
Fox Sparrow	R	R										R
Song Sparrow	U	U	U	R	R	X					U	U
Lincoln's Sparrow	U	U	U	U	R	X				U	U	U
Swamp Sparrow				R						R		
White-throated Sparrow	U	U	FC	FC	R					R	R	U
Harris's Sparrow			R							X	R	R
White-crowned Sparrow	U	U	U	U	R					R	U	U
Dark-eyed Junco	U	FC	U	VR							U	U
Cardinals, Grosbeaks & Buntings												
Northern Cardinal**	C	C	C	C	C	C	C	C	C	C	C	C
Rose-breasted Grosbeak				R	R							
Blue Grosbeak**				U	U	U	U	U				
Lazuli Bunting*				R	R	VR	VR					
Indigo Bunting**				U	FC	U	U	U	U	R		

SPECIES	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Painted Bunting**				FC	C	C	C	FC	FC	R		
Dickcissel**				C	C	U	R	R	R			
Blackbirds												
Bobolink				X								
Red-winged Blackbird**	C	C	C	FC	FC	FC	FC	FC	C	C	C	C
Eastern Meadowlark**	C	C	FC	U	U	U	U	U	U	U	FC	C
Yellow-headed Blackbird				C	FC	X	X					
Brewer's Blackbird	R	R	R	Ca	X							
Common Grackle**			U	FC	FC	U	U					
Great-tailed Grackle**	C	C	C	C	C	C	C	C	C	C	C	C
Shiny Cowbird					X	X						
Bronzed Cowbird*				R	R	R	R					
Brown-headed Cowbird**	C	C	A	C	FC	FC	FC	R	FC	FC	FC	U
Orchard Oriole**			X	R	U	U	U					
Bullock's Oriole					X							
Baltimore Oriole				R	R							
Finches												
Purple Finch				X	X							
House Finch**	U	U	U	U	U	U	U	U	U	U	U	U
Pine Siskin				VR								
Lesser Goldfinch**				R	R	R	R			R		
American Goldfinch	U	FC	U	R	VR	X	Ca				U	U
Evening Grosbeak				X								
Weavers												
House Sparrow**	C	C	C	C	C	C	C	C	C	C	C	C

The following species have been observed on Fort Hood, but details on these observations (e.g., abundance, month seen) are missing.

Bufflehead
Common Merganser
Red-breasted Merganser
Common Loon
Eared Grebe
Hudsonian Godwit
Semipalmated Sandpiper
Short-billed Dowitcher
Caspian Tern
Least Tern
Barn Owl
Rufous Hummingbird
Red-headed Woodpecker
Plumbeous Vireo
Winter Wren
Blue-winged Warbler
Black-headed Grosbeak

APPENDIX H

Plant Species at Fort Hood

Vascular Plant List of Fort Hood Military Reservation, Bell and Coryell counties, Texas
Working draft as of October 2004; compiled by L.L. Sanchez, Fort Hood, Texas; includes naturalized species, excludes landscape plantings in cantonment areas; nomenclature follows Diggs, Lipscomb, and O'Kennon (1999).

DIVISION Family Species {Synonym} — **Common Names**

EQUISETOPHYTA — **HORSETAILS**

Equisetaceae	**Horsetail Family**
Equisetum laevigatum A. Braun	smooth horsetail, cola de caballo

POLYPODIOPHYTA — **FERNS**

Aspleniaceae	**Spleenwort Family**
Asplenium resiliens Kunze	little ebony spleenwort

Dryopteridaceae	**Wood Fern Family**
Cyrtomium falcatum (L.f.) Presl	Asian net-veined holly fern
Woodsia obtusa (Spreng.) Torr. subsp. *occidentalis* Windham	common woodsia, blunt-lobed woodsia, large woodsia

Marsileaceae	**Pepperwort Family**
Marsilea vestita Hook. & Grev. subsp. *vestita*	hooked pepperwort, water clover

Polypodiaceae	**Polypody Family**
Pleopeltis polypodioides (L.) E.B. Andrews & Windham subsp. *michauxiana* (Weath.) E.B. Andrews & Windham {*Polypodium polypodioides* (L.) Watt var. *michauxiana* Weath.}	resurrection fern, gray polypody

Pteridaceae	**Maidenhair Fern Family**
Adiantum capillus-veneris L.	Venus'-hair fern, southern maidenhair
Argyrochosma dealbata (Pursh) Windham {*Cheilanthes dealbata* Pursh} {*Notholaena dealbata* (Pursh) Kunze} {*Pellaea dealbata* (Pursh) Prantl}	powdery cloak fern, false cloak fern
Cheilanthes alabamensis (Buckley) Kunze	Alabama lip fern, smooth lip fern
Cheilanthes horridula Maxon	rough lip fern
Pellaea atropurpurea (L.) Link	purple cliff-brake, blue fern

Thelypteridaceae	**Marsh Fern Family**
Thelypteris kunthii (Desv.) C.V. Morton	southern shield fern

PINOPHYTA — **CONIFERS**

Cupressaceae	**Cypress Family**
Juniperus ashei J. Buchholz	Ashe juniper, mountain cedar, Mexican juniper
Juniperus pinchotii Sudw.	red-berry juniper
Juniperus virginiana L.	eastern red-cedar, pencil-cedar, red juniper
Thuja orientalis L.	Oriental arbor-vitae

MAGNOIOPHYTA-DICOTYLEDONAE — **DICOTS**

Acanthaceae	**Acanthus Family**
Dicliptera brachiata (Pursh) Spreng.	false mint

DIVISION Family Species {Synonym}	Common Names
Dyschoriste linearis (Torr. & A. Gray) Kuntze	narrow-leaf snakeherb
Justicia americana (L.) Vahl	American water-willow
Ruellia drummondiana (Nees) A. Gray	Drummond's ruellia
Ruellia humilis Nutt.	low ruellia, prairie-petunia
Ruellia metziae Tharp	wild petunia
Ruellia nudiflora (Engelm. & A. Gray) Urban var. *nudiflora*	violet ruellia
Ruellia nudiflora (Engelm. & A. Gray) Urban var. *runyonii* (Tharp & Barkl.) B.L. Turner {*Ruellia runyonii* Tharp & Barkl.}	wild ruellia

Aceraceae	**Maple Family**
Acer grandidentatum Nutt. var. *sinuosum* (Rehder) Little	Plateau big-tooth maple, limerock maple
Acer negundo L.	box-elder, ash-leaf maple

Amaranthaceae	**Amaranth Family**
Alternanthera caracasana Kunth	matt chaff-flower
Amaranthus albus L.	tumbleweed, white amaranth
Amaranthus blitoides S. Watson	prostrate pigweed
Amaranthus palmeri S. Watson	carelessweed, Palmer's pigweed, redroot
Gossypianthus lanuginosus (Poir.) Moq. var. *lanuginosus*	woolly cotton-flower
Iresine heterophylla Standl.	bloodleaf

Anacardiaceae	**Sumac Family**
Rhus lanceolata (A. Gray) Britton	flame-leaf sumac, prairie sumac
Rhus trilobata Nutt. {*Rhus aromatica* Aiton var. *flabelliformis* Shinners}	skunkbush
Rhus virens Lindh. ex A. Gray	evergreen sumac, tobacco sumac, lentisco
Toxicodendron radicans (L.) Kuntze subsp. *verrucosum* (Scheele) Gillis	poison-ivy, poison-oak, hiedra

Apiaceae	**Parsley Family**
Bifora americana Benth. & Hook. f. ex S. Watson	prairie-bishop
Chaerophyllum tainturieri Hook. var. *dasycarpum* Hook. ex S. Watson	hairy-fruit chervil
Chaerophyllum tainturieri Hook. var. *tainturieri*	chervil
Cyclospermum leptophyllum (Pers.) Sprague ex Britton & Wilson {*Apium leptophyllum* (Pers.) F. Muell. ex Benth.}	slim-lobe celery
Cymopterus macrorhizus Buckley	big-root wavewing
Daucus pusillus Michx.	rattlesnake-weed, southwestern carrot
Daucus carota L.	wild carrot, Queen Anne's lace
Eryngium leavenworthii Torr. & A. Gray	Leavenworth's eryngo
Hydrocotyle umbellata L.	water-pennywort
Hydrocotyle verticillata Thunb. var. *triradiata* (A. Rich.) Fernald	three-rayed water-pennywort
Hydrocotyle verticillata Thunb. var. *verticillata*	whorled water-pennywort
Polytaenia nuttallii DC.	prairie-parsley, Texas parsley
Sanicula canadensis L.	black snakeroot, Canada sanicle
Spermolepis echinata (Nutt. ex DC.) A. Heller	beggar's-lice, bristly scaleseed
Spermolepis inermis (Nutt. ex DC.) Mathias & Constance	spreading scale-seed
Torilis arvensis (Huds.) Link	hedge-parsley

DIVISION Family Species {Synonym}	**Common Names**
Torilis nodosa (L.) Gaertn.	knotted hedge-parsley

Apocynaceae	**Dogbane Family**
Amsonia ciliata Walter var. *texana* (A. Gray) J.M. Coult.	Texas slimpod, Texas amsonia
Amsonia longiflora Torr. var. *salpignantha* (Woodson) S.P. McLaughlin	trumpet slimpod, blue-star
Apocynum cannibinum L.	Indian-hemp, hemp dogbane
Vinca major L.	big-leaf periwinkle

Aquifoliaceae	**Holly Family**
Ilex decidua Walter	deciduous holly, possumhaw, winterberry, prairie holly
Ilex vomitoria Sol. in Aiton	yaupon, yaupon holly, evergreen holly

Aristolochiaceae	**Birthwort Family**
Aristolochia serpentaria L.	Virginia Dutchman's pipe

Asclepiadaceae	**Milkweed Family**
Asclepias asperula (Decne.) Woodson subsp. *capricornu* (Woodson) Woodson	antelope-horns, trailing milkweed
Asclepias oenotheroides Cham. & Schltdl.	side-cluster milkweed, hierba de zizotes
Asclepias verticillata L.	whorled milkweed
Asclepias viridiflora Raf.	green-flower milkweed, green antelope-horns, wand milkweed
Asclepias viridis Walter	green milkweed, antelope-horns
Cynanchum racemosum (Jacq.) Jacq. var. *unifarium* (Scheele) Sundell {*Cynanchum unifarium* (Scheele) Woodson}	talayote, cynanchum
Funastrum crispum (Benth.) Schltr. {*Sarcostemma crispum* Benth.}	wavy-leaf twinevine, wavy-leaf milkweedvine
Matelea biflora (Raf.) Woodson	purple milkvine, two-flower milkvine
Matelea edwardsensis Correll	Plateau milkvine
Matelea gonocarpos (Walter) Shinners	anglepod
Matelea reticulata (Engelm. ex A. Gray) Woodson	net-vein milkvine, green milkvine

Asteraceae	**Aster Family**
Achillea millefolium L.	milfoil, western yarrow, common yarrow
Ambrosia artemisiifolia L.	common ragweed, short ragweed
Ambrosia psilostachya DC.	western ragweed, perennial ragweed
Ambrosia trifida L. var. *texana* Scheele	giant ragweed, blood ragweed, buffaloweed
Aphanostephus skirrhobasis (DC.) Trel.	Arkansas lazy daisy
Arnoglossum plantagineum Raf. {*Cacalia plantaginea* (Raf.) Shinners}	Indian-plantain
Artemisia ludoviciana Nutt. subsp. *mexicana* (Willd. ex Spreng.) D.D. Keck	Mexican sagebrush, western mugwort
Aster drummondii Lindl. var. *texanus* (E.S. Burgess) A.G. Jones {*Aster texanus* Burgess}	Texas aster
Aster ericoides L.	heath aster
Aster oblongifolius Nutt.	aromatic aster, oblong-leaf aster

DIVISION Family Species {Synonym}	**Common Names**
Aster sericeus Vent.	silky aster
Aster subulatus Michx. var. *ligulatus* Shinners	wireweed, hierba del marrano
Baccharis neglecta Britton	Roosevelt-weed, jara dulce, seep-willow
Bidens frondosa L.	beggar-ticks
Brickellia cylindracea A. Gray & Engelm.	gravel-bar brickell-bush
Brickellia eupatorioides (L.) Shinners var. *texana* (Shinners) Shinners {*Kuhnia eupatorioides* L.}	prairie kuhnia
Calyptocarpus vialis Less.	straggler daisy, prostrate lawnflower
Carduus tenuiflorus Curtis	slender bristle-thistle
Carthamus lanatus L.	distaff-thistle
Centaurea americana Nutt.	basket-flower
Centaurea melitensis L.	Malta star-thistle, tocalote
Chaetopappa asteroides Nutt. ex DC.	common least daisy
Chloracantha spinosa (Benth.) B.L. Nesom {*Aster spinosus* Benth.}	Mexican devil-weed, spiny-aster, devilweed-aster
Cirsium engelmannii Rydb. {*Cirsium terraenigrae* Shinners}	blackland thistle
Cirsium ochrocentrum A. Gray	yellow-spine thistle
Cirsium texanum Buckley	Texas thistle, southern thistle
Cirsium undulatum (Nutt.) Spreng.	wavy-leaf thistle, pasture thistle
Conyza canadensis (L.) Cronq. var. *canadensis*	horse-tail conyza
Conyza canadensis (L.) Cronq. var. *glabrata* (A. Gray) Cronq.	horseweed
Coreopsis tinctoria Nutt.	plains coreopsis
Coreopsis wrightii (A. Gray) H.M. Parker	rock coreopsis
Dracopis amplexicaulis (Vah.)Cass.	clasping coneflower, clasping-leaf coneflower, black-eyed Susan
Echinacea angustifolia DC.	blacksamson, purple coneflower
Eclipta prostrata (L.) L. {*Eclipta alba* L.}	pieplant, yerba de tago
Elephantopus carolinianus Raeusch.	leafy elephantopus
Engelmannia peristenia (Raf.) Goodman & C.A. Lawson {*Engelmannia pinnatifida* A. Gray ex Nutt.}	Engelmann's daisy
Erechtites hieraciifolia (L.) Raf. ex DC.	American burnweed, fireweed
Erigeron modestus A. Gray	plains fleabane, prairie fleabane
Erigeron philadelphicus L.	Philadelphia fleabane
Erigeron strigosus Muhl. ex Willd. var. *strigosus*	prairie fleabane, white-top
Erigeron tenuis Torr. & A. Gray	slender fleabane
Eupatorium coelestinum L.	mistflower, blue boneset
Eupatorium havanense Kunth {*Ageratina havanensis* (Kunth) King & H.E. Robins.}	shrubby boneset
Eupatorium serotinum Michx.	late eupatorium, fall boneset
Evax prolifera Nutt. ex DC.	big-head evax, flat-head rabbit-tobacco
Evax verna Raf.	many-stem evax, round-head rabbit-tobacco
Gaillardia pulchella Foug.	Indian-blanket, fire-wheels
Gaillardia suavis (A. Gray & Engelm.) Britton & Rusby	rayless gaillardia, pincushion daisy
Gamochaeta pensylvanica (Willd.) Cabrera {*Gnaphalium pensylvanicum* Willd.}	cudweed
Grindelia lanceolata Nutt.	fall gumweed, gulf gumweed
Grindelia nuda A.W. Wood	rayless gumweed

DIVISION Family Species {Synonym}	Common Names
Gutierrezia dracunculoides (DC.) S.F. Blake {*Amphiachyris dracunculoides* (DC.) Nutt.} {*Xanthocephalum drancunculoies* (DC.) Shinners}	common broomweed
Gutierrezia texana (DC.) Torr. & A. Gray {*Xanthocephalum texanum* (DC.) Shinners}	Texas broomweed, snakeweed
Helenium amarum (Raf.) H. Rock var. *amarum*	yellow bitterweed
Helenium autumnale L.	common sneezeweed, tall sneezeweed, staggerwort
Helenium elegans DC.	elegant sneezeweed
Helenium microcephalum DC.	small-head sneezeweed, small sneezeweed
Helianthus annuus L.	common sunflower, mirasol
Helianthus maximiliani Schrad.	Maximilian sunflower
Heterotheca canescens (DC.) Shinners	gray gold-aster
Heterotheca subaxillaris (Lam.) Britton & Rusby {*Heterotheca latifolia* Buckley}	camphorweed
Hymenopappus artemisiifolius DC.	ragweed woolly-white
Hymenopappus filifolius Hook. var. *cinereus* (Rydb.) I.M. Johnst.	woolly-white
Hymenopappus scabiosaeus L'Her. var. *corymbosus* (Torr. & A. Gray) B.L. Turner	old plainsman
Hymenopappus tenuifolius Pursh	chalkhill
Iva angustifolia Nutt. ex DC.	narrow-leaf sumpweed
Iva annua L.	marsh-elder
Krigia cespitosa (Raf.) K.L. Chambers {*Krigia gracilis* (DC.) Shinners}	dwarf dandelion
Lactuca floridana (L.) Gaertn.	woodland lettuce
Lactuca ludoviciana (Nutt.) Riddell	western wild lettuce
Lactuca serriola L.	prickly lettuce
Liatris mucronata DC.	narrow-leaf gayfeather
Lindheimera texana Engelm. & A. Gray	Texas-star, Lindheimer's daisy
Lygodesmia texana (Torr. & A. Gray) Greene	Texas skeleton-plant, purple-dandelion
Marshallia caespitosa Nutt. ex DC. var. *signata* Beadle & F.E. Boynton	Barbara's buttons
Melampodium leucanthum Torr. & A. Gray	rock daisy, black-foot daisy
Packera glabella (Poir.) C. Jeffrey {*Senecio glabellus* Poir.}	butterweed, yellowtop
Packera obovata (Muhl. ex Willd.) W.A. Weber & Á. Löve {*Senecio obovatus* Muhl. ex Willd.}	golden groundsel
Packera tampicana (DC.) C. Jeffrey Löve {*Senecio tampicanus* DC.} {*Senecio imparipinnatus* Klatt.}	yellowtop
Palafoxia callosa (Nutt.) Torr. & A. Gray	small palafoxia
Parthenium hysterophorus L.	false ragweed
Pectis angustifolia Torr. var. *fastigiata* (A. Gray) D.J. Keil	pectis
Pluchea camphorata (L.) DC.	camphorweed
Pluchea odorata (L.) Cass. {*Pluchea purpurascens* (Sw.) DC.}	canela, marsh fleabane
Pseudognaphalium obtusifolium (L.) Hillard & Burtt {*Gnaphalium obtusifolium* L.}	fragrant cud-weed
Pyrrhopappus grandiflorus (Nutt.) Nutt.	tuber false dandelion

DIVISION Family Species {Synonym}	**Common Names**
Pyrrhopappus pauciflorus (D. Don) DC. {*Pyrrhopappus multicaulis* DC. var. *geiseri* (Shinners) Northington}	Texas dandelion, many-stem false dandelion
Ratibida columnifera (Nutt.) Wooton & Standl. {*Ratibida columnaris* (Sims) D. Don}	Mexican hat, prairie coneflower
Rudbeckia hirta L. var. *pulcherrima* Farw.	black-eyed-Susan, brown-eyed Susan
Silphium albiflorum A. Gray	white rosinweed
Silphium laciniatum L.	compassplant
Silphium radula Nutt. {*Silphium asperrimum* Hook.}	rough-stem rosinweed
Silybum marianum (L.) Gaertn.	blessed milk-thistle
Simsia calva (Engelm. & A. Gray) A. Gray	awnless bush-sunflower
Smallanthus uvedalia (L.) Mack. ex Small {*Polymnia uvedalia* (L.) L. var. *densipilis* Blake}	bear's-foot, hairy leafcup
Solidago canadensis L. var. *scabra* Torr. & A. Gray {*Solidago altissima* L.}	common goldenrod, tall goldenrod
Solidago gigantea Aiton	giant goldenrod
Solidago nemoralis Aiton var. *longipetiolata* (Mack. & Bush) E.J. Palmer & Steyerm.	old-field goldenrod, prairie goldenrod
Solidago radula Nutt.	rough goldenrod
Sonchus asper (L.) Hill	prickly sow-thistle
Taraxacum officinale F.H. Wigg.	common dandelion
Tetraneuris linearifolia (Hook.) Greene {*Hymenoxys linearifolia* Hook.}	slender-leaf bitterweed
Tetraneuris scaposa (DC.) Greene {*Hymenoxys scaposa* (DC.) Parker}	plains yellow daisy, slender-stem bitterweed, four-nerve daisy
Thelesperma filifolium (Hook.) A. Gray var. *filifolium*	greenthread
Thelesperma simplicifolium A. Gray	slender greenthread, Navajo tea
Thymophylla pentachaeta (DC.) Small {*Dyssodia pentachaeta* (DC.) B.L. Rob.}	common dogweed, parralena
Verbesina encelioides (Cav.) Benth. & Hook. f. ex A. Gray	cowpen daisy
Verbesina lindheimeri B.L. Rob. & Greenm.	Lindheimer's crownbeard
Verbesina virginica L.	frostweed, iceplant
Vernonia baldwinii Torr.	western ironweed
Vernonia lindheimeri A. Gray & Engelm.	woolly ironweed
Vernonia x guadalupensis A. Heller	hybrid ironweed
Viguiera dentata (Cav.) Spreng.	sunflower golden-eye
Xanthium strumarium L. var. *canadense* (Mill.) Torr. & A. Gray	cocklebur

Berberidaceae	**Barberry Family**
Berberis trifoliolata Moric.	agarito, agarita, algeritas, currant-of-Texas
Nandina domestica Thunb.	sacred-bamboo, heavenly-bamboo, burning-bush

Bignoniaceae	**Catalpa Family**
Campsis radicans (L.) Seem. ex Bureau	common trumpet-creeper
Chilopsis linearis (Cav.) Sweet	desert-willow

Boraginaceae	**Borage Family**

DIVISION Family Species {Synonym}	**Common Names**
Buglossoides arvense (L.) I.M. Johnst. {*Lithospermum arvense* L.}	buglossoides
Heliotropium indicum L.	India heliotrope, turnsole
Heliotropium procumbens Mill.	heliotrope
Heliotropium tenellum (Nutt.) Torr.	white heliotrope
Heliotropium torreyi I.M. Johnston	heliotrope
Lithospermum incisum Lehm.	narrow-leaf gromwell, puccoon
Myosotis macrosperma Engelm.	spring forget-me-not
Onosmodium bejariense DC. ex A. DC. var. *bejariense* {*Onosmodium molle* Michx. subsp. *bejariense* (DC. ex A. DC.) Cochrane}	bejar marbleseed, false-gromwell

Brassicaceae	**Mustard Family**
Arabis petiolaris (A. Gray) A. Gray	Brazos rockcress
Capsella bursa-pastoris (L.) Medik.	shepherd's purse
Cardamine parviflora L. var. *arenicola* (Britton) O.E. Schulz.	sand bittercress
Draba cuneifolia Nutt. ex Torr. & A. Gray	wedge-leaf draba, whitlow-grass
Draba platycarpa Torr. & A. Gray	broad pod draba
Erysimum capitatum (Douglas ex Hook.) Greene	plains erysimum, western wallflower
Erysimum repandum L.	spreading erysimum, bushy wallflower
Lepidium austrinum Small	southern pepperweed
Lepidium virginicum L.	Virginia pepper-grass
Lesquerella gordonii (A. Gray) S. Watson	Gordon's bladderpod, popweed
Lesquerella gracilis (Hook.) S. Watson subsp. *gracilis*	white bladderpod
Lesquerella recurvata (Engelm. ex A. Gray) S. Watson	slender bladderpod
Rapistrum rugosum (L.) All.	wild turnip
Rorippa nasturtium-aquaticum (L.) Hayek {*Nasturtium officinale* R. Br.}	watercress
Rorippa sessiliflora (Nutt.) Hitch.	stalk-less yellowcress

Buddlejaceae	**Buddleja Family**
Polypremum procumbens L.	juniper-leaf, pollyprim

Cactaceae	**Cactus Family**
Coryphantha sulcata (Engelm.) Britton & Rose {*Mammillaria sulcata* (Engelm.}	pineapple cactus, finger cactus, nipple cactus
Echinocactus texensis Hopffer	horse crippler, devil's pincushion, manca caballo
Echinocereus reichenbachii (Terscheck ex Walp.) F. Haage	lace cactus, white lace, hedgehog cactus
Opuntia engelmannii Salm-Dyck var. *lindheimeri* (Engelm.) B.D. Parfitt & Pinkava {*Opuntia lindheimeri* Engelm.}	Texas prickly-pear, nopal prickly-pear
Opuntia engelmannii Salm-Dyck var. *linguiformis* (Griffiths) B.D. Parfitt & Pinkava	cow's-tongue prickly-pear, lengua de vaca
Opuntia leptocaulis DC.	desert Christmas cactus, pencil cactus, tasajillo, Christmas cholla
Opuntia macrorhiza Engelm.	plains prickly-pear, grassland prickly-pear
Opuntia phaeacantha Engelm. var. *major* Engelm.	brown-spine prickly-pear, Engelmann's prickly-pear

Callitrichaceae	**Water-starwort Family**

DIVISION Family Species {Synonym}	Common Names
Callitriche heterophylla Pursh	water-starwort, large waterwort

Campanulaceae	**Bluebell Family**
Lobelia cardinalis L.	cardinal flower
Triodanis coloradoensis (Buckley) McVaugh	western Venus'-looking-glass
Triodanis perfoliata (L.) Nieuwl. var. *biflora* (Ruiz & Pav.) T.R. Bradley {*Triodanis biflora* (Ruiz & Pav.) Green}	small Venus'-looking-glass
Triodanis perfoliata (L.) Nieuwl. var. *perfoliata*	clasping Venus'-looking-glass

Capparaceae	**Caper Family**
Polanisia dodecandra (L.) DC. subsp. *trachysperma* (Torr. & A. Gray) H.H. Iltis	clammy-weed

Caprifoliaceae	**Honeysuckle Family**
Abelia grandiflora Rehd.	abelia
Lonicera albiflora Torr. & A. Gray	white honeysuckle, bushy honeysuckle
Lonicera japonica Thunb.	Japanese honeysuckle
Sambucus nigra L. var. *canadensis* (L.) Bolli {*Sambucus canadensis* L.}	common elderberry, American elderberry
Symphoricarpos orbiculatus Moench	Indian-currant, coral-berry, buckbrush
Viburnum rufidulum Raf.	southern blackhaw, rusty blackhaw, downy viburnum

Caryophyllaceae	**Pink Family**
Arenaria benthamii Fenzl ex Torr. & A. Gray	hilly sandwort
Arenaria serpyllifolia L.	thyme-leaved sandwort
Cerastium brachypodum (Engelm. ex A. Gray) B.L. Rob.	short-stalk chickweed
Cerastium glomeratum Thuill.	chickweed
Paronychia virginica Spreng.	Park's nailwort, broom nailwort
Polycarpon tetraphyllum L.	four-leaf manyseed
Silene antirrhina L.	sleepy catchfly
Stellaria media (L.) Vill.	tenpetal, common chickweed
Stellaria pallida (Dumort.) Crep.	lesser chickweed

Chenopodiaceae	**Goosefoot Family**
Chenopodium album L.	lamb's quarters, pigweed
Chenopodium ambrosioides L.	Mexican tea
Chenopodium leptophyllum (Moq.) Nutt. ex S. Watson	slim-leaf goosefoot, narrow-leaf goosefoot
Monolepis nuttalliana (Schult.) Greene	Nuttall's monolepis, poverty weed

Cistaceae	**Rockrose Family**
Helianthemum georgianum Chapm.	Georgia rock-rose
Helianthemum rosmarinifolium Pursh.	rosemary sun-rose
Lechea mucronata Raf.	pin-weed
Lechea san-sabeana (Buckley) Hodgdon	San Saba pinweed
Lechea tenuifolia Michx.	narrow-leaf pinweed

Convolvulaceae	**Morning Glory Family**
Convolvulus equitans Benth.	gray bindweed, Texas bindweed
Dichondra carolinensis Michx.	pony-foot

DIVISION Family Species {Synonym}	**Common Names**
Evolvulus nuttallianus Schult.	hairy evolvulus
Evolvulus sericeus Sw.	white evolvulus, silky evolvulus
Ipomoea cordatotriloba Dennst. var. *cordatotriloba* {*Ipomoea trichocarpa* Ell.}	sharp-pod morning-glory, purple bindweed
Ipomoea cordatotriloba Dennst. var. *torreyana* (A. Gray) D.F. Austin {*Ipomoea trichocarpa* Ell. var. *torreyana* (A. Gray) Shinners}	cotton morning-glory, purple bindweed
Ipomoea lacunosa L.	pitted morning-glory, white morning-glory

Cornaceae	**Dogwood Family**
Cornus drummondii C.A. Mey.	rough-leaf dogwood

Crassulaceae	**Stonecrop Family**
Sedum nuttallianum Raf.	yellow stonecrop
Sedum pulchellum Michx.	Texas stonecrop

Cucurbitaceae	**Gourd Family**
Cucurbita foetidissima Kunth	buffalo gourd
Ibervillea lindheimeri (A. Gray) Greene	balsam gourd, Lindheimer's globeberry
Sicyos angulatus L.	one-seed bur-cucumber, wall bur-cucumber

Cuscutaceae	**Dodder Family**
Cuscuta sp.	dodder
Cuscuta exaltata Englem.	tree dodder, tall dodder

Ebenaceae	**Persimmon Family**
Diospyros texana Scheele	Texas persimmon, Mexican persimmon, black persimmon
Diospyros virginiana L.	common persimmon, eastern persimmon

Elatinaceae	**Waterwort Family**
Bergia texana (Hook.) Walp.	Texas bergia

Euphorbiaceae	**Spurge Family**
Acalypha gracilens A. Gray	slender copperleaf
Acalypha ostryifolia Riddell	hop-hornbeam copperleaf
Acalypha phleoides Cav. {*Acalypha lindheimeri* Muell.Arg.}	Lindheimer's copperleaf
Chamaesyce fendleri (Torr.& A. Gray) Small {*Euphorbia fendleri* Torr.& A. Gray}	creeping spurge
Chamaesyce maculata (L.) Small {*Euphorbia maculata* L.}	spotted spurge
Chamaesyce missurica (Raf.) Shinners {*Euphorbia missurica* Raf.}	prairie spurge
Chamaesyce nutans (Lag.) Small {*Euphorbia nutans* Lag.}	eyebane
Chamaesyce prostrata (Aiton) Small {*Euphorbia prostrata* Aiton}	prostrate euphorbia
Chamaesyce serpens (Kunth) Small {*Euphorbia serpens* Kunth}	mat euphorbia, hierba de la golondrina

DIVISION Family Species {Synonym}	**Common Names**
Chamaesyce villifera (Scheele) Small {*Euphorbia villifera* Scheele}	hairy spurge
Cnidoscolus texanus (Muell.Arg.) Small	Texas bull nettle
Croton alabamensis E.A. Sm. ex Chapman var. *texensis* Ginzbarg	Texabama croton
Croton capitatus Michx. var. *lindheimeri* (Engelm. & A. Gray) Muell.Arg.	woolly croton
Croton fruticulosus Torr.	encinilla, shrubby croton
Croton glandulosus L. var. *lindheimeri* Mull.Arg.	Lindheimer's croton
Croton monanthogynus Michx.	doveweed, prairie-tea
Croton texensis (Klotzsch) Muell.Arg.	Texas croton
Ditaxis humilis (Engelm. & A. Gray) Pax var. *humilis* {*Argythamnia humilis* (Engelm. & A. Gray) Muell.Arg.}	low wild mercury
Ditaxis mercurialina (Nutt.) J.M. Coult. {*Argythamnia mercurialina* (Nutt.) Muell.Arg.}	tall wild mercury, tall ditaxis
Ditaxis simulans (J. Ingram) Radcl.-Sm. & Govaerts {*Argythamnia simulans* J. Ingram}	wild mercury
Euphorbia bicolor Engelm. & A. Gray	snow-on-the-prairie
Euphorbia cyathophora Murray	wild poinsettia
Euphorbia dentata Michx.	toothed spurge
Euphorbia marginata Pursh	snow-on-the-mountain
Euphorbia roemeriana Scheele	Roemer's spurge
Euphorbia spathulata Lam.	warty euphorbia, warty spurge
Phyllanthus polygonoides Nutt. ex Spreng.	knotweed leaf-flower
Sapium sebiferum (L.) Roxb.	Chinese tallow tree, vegetable tallow tree
Stillingia texana I.M. Johnston	Texas stillingia, queen's delight
Tragia brevispica Engelm. & A. Gray	short-spike noseburn, climbing noseburn
Tragia ramosa Torr.	catnip noseburn

Fabaceae	**Legume Family**
Acacia angustissima (Mill.) Kuntze var. *hirta* (Nutt.) B.L. Rob.	fern acacia, prairie acacia
Acacia farnesiana (L.) Willd.	huisache, sweet acacia
Albizia julibrissin Durazzo	mimosa tree, silktree
Amorpha fruticosa L.	false indigo, bastard indigo, indigo-bush amorpha
Astragalus lotiflorus Hook.	lotus milk-vetch
Astragalus mollissimus Torr.	crazy weed, Texas loco, woolly loco
Astragalus nuttallianus DC. var. *nuttallianus*	Nuttall's milk-vetch
Astragalus reflexus Hook & A. Gray	Texas milk-vetch
Astragalus wrightii A. Gray	Wright's milk-vetch
Caesalpinia gilliessii (Hook.) Wall. ex D. Dietr.	bird-of-paradise, poinciana, pop-bean bush
Cercis canadensis L. var. *texensis* (S. Watson) M. Hopkins	Texas redbud
Chamaecrista fasciculata (Michx.) Greene {*Cassia fasciculata* Michx. var. *rostrata* (Wooton & Standl.) B.L. Turner}	partridge pea
Dalea aurea Nutt. ex Pursh	golden dalea
Dalea compacta Spreng. var. *pubescens* (A. Gray) Barneby {*Petalostemum pulcherrimus* (Heller) Heller}	showy prairie-clover
Dalea enneandra Nutt.	big-top dalea
Dalea frutescens A. Gray	black dalea

DIVISION Family Species {Synonym}	**Common Names**
Dalea hallii A. Gray	Hall's prairie-clover
Dalea multiflora (Nutt.) Shinners {*Petalostemon multiflorum* Nutt.}	round-head dalea, white prairie-clover
Dalea tenuis (J.M. Coult.) Shinners {*Petalostemon tenuis* (Colt.) Heller} {*Dalea stanfieldii* (Small) Shinners}	prairie clover
Desmanthus illinoensis (Michx.) MacMill. ex B.L. Rob. & Fernald.	Illinois bundle-flower
Desmanthus leptolobus Torr. & A. Gray	prairie bundle-flower
Desmanthus velutinus Scheele	velvet bundle-flower
Desmodium paniculatum (L.) DC.	panicled tick-clover
Desmodium psilophyllum Schltdl. {*Desmodium wrightii* A. Gray}	Wright's tick-clover, simple-leaf tick-clover
Eysenhardtia texana Scheele	Texas kidneywood, vara dulce
Galactia volubilis (L.) Britton {*Galactia regularis* (L.) B.S.P.}	downy milk-pea
Gleditsia triacanthos L.	common honey-locust, honeyshuck
Indigofera miniata Ortega var. *leptosepala* (Nutt. ex Torr. & A. Gray) B.L. Turner	western scarlet-pea, western indigo
Lathyrus hirsutus L.	rough-pea, singletary vetchling
Lathyrus pusillus Elliott	low peavine
Lespedeza procumbens Michx.	trailing bush-clover
Lespedeza repens (L.) Barton	creeping bush-clover
Lespedeza texana Britton	Texas bush-clover
Lespedeza virginica (L.) Britton	slender bush-clover
Lotus unifoliolatus (Hook.) Benth. {*Lotus purshianus* F.E. & E.G. Clem.}	Pursh's deer-vetch
Lupinus texensis Hook.	Texas bluebonnet
Medicago lupulina L.	black medick
Medicago minima (L.) L.	small bur-clover
Medicago orbicularis (L.) Bartal.	button clover
Melilotus albus Medik.	white sweet-clover
Melilotus indicus (L.) All.	sour-clover
Melilotus officinalis (L.) Lam.	yellow sweet-clover
Mimosa aculeaticarpa Ortega var. *biuncifera* (Benth.) Barneby {*Mimosa biuncifera* Benth.}	catclaw, wait-a-bit, wait-a-minute
Mimosa borealis A. Gray	fragrant mimosa, pink mimosa, catclaw
Mimosa latidens (Small) B.L. Turner {*Schrankia latidens* (Small) K. Schum.}	Karnes schrankia
Mimosa roemeriana Scheele {*Mimosa quadrivalvis* L. var. *platycarpa* (A. Gray) Barneby} {*Schrankia roemeriana* (Scheele) Blank.}	Roemer's sensitive-briar
Neptunia lutea (Leavenw.) Benth.	yellow-puff
Parkinsonia aculeata L.	retama, paloverde, horse-bean, Jerusalem-thorn
Pediomelum cuspidatum (Pursh) Rydb. {*Psoralea cuspidata* Pursh}	tall-bread scurf-pea, Indian-turnip
Pediomelum cyphocalyx (A. Gray) Rydb. {*Psoralea cyphocalyx* A. Gray}	turnip-root scurf-pea, wand psoralea
Pediomelum hypogaeum (Nutt. ex Torr. & A. Gray) Rydb. var. *scaposum* (A. Gray) Mahler {*Psoralea hypogaea* T. & G. var. *scaposa* A. Gray}	stemless scurf-pea

DIVISION Family Species {Synonym}	Common Names
Pediomelum latestipulatum (Shiners) Mahler var. *appressum* (Ockendon) Ghandi& L.E. Br. {*Psoralea latestipulata* Shinners var. *appressum* Ockendon}	scurf-pea
Pediomelum linearifolium (Torr. & A. Gray) J.W. Grimes {*Psoralea linearifolia* Torr. & A. Gray}	narrow-leaf scurf-pea
Pediomelum rhombifolium (Torr. & A. Gray) Rydb. {*Psoralea rhombifolia* Torr. & A. Gray}	round-leaf scurf-pea, brown-flowered psoralea
Prosopis glandulosa Torr.	honey mesquite, algaroba
Psoralidium tenuiflorum (Pursh) Rydb. {*Psoralea tenuiflora* Pursh}	slim-leaf scurf-pea
Pueraria montana (Lour.) Merr. var. *lobata* (Willd.) Maesen & Almeida	kudzu, kudsu, kudzuvine
Rhynchosia senna Gillies ex Hook. var. *texana* (Torr. & A. Gray) M.C. Johnst. {*Rhynchosia texana* Torr. & A. Gray}	snout-bean
Robinia pseudoacacia L.	black locust, false acacia, bastard acacia
Senna marilandica (L.) Link {*Cassia marilandica* L.}	wild senna, Maryland senna
Senna roemeriana (Scheele) H.S. Irwin & Barneby {*Cassia roemeriana* Scheele}	two-leaf senna
Sesbania herbacea (Mill.) McVaugh {*Sesbania exaltata* (Raf.) Rydb. ex A.W. Hill} {*Sesbania macrocarpa* Muhl. ex Raf.}	coffee-bean, bequilla
Sesbania vesicaria (Jacq.) Elliott	bladder pod
Sophora affinis Torr. & A. Gray	Eve's necklace, Texas sophora
Sophora secundiflora (Ortega) Lag. ex DC.	Texas mountain laurel, mescal-bean, frijolito
Strophostyles helvula (L.) Elliott	amerique bean
Stylosanthes biflora (L.) B.S.P.	side-beak pencil-flower
Trifolium repens L.	white clover, Dutch clover
Vicia ludoviciana Nutt. subsp. *leavenworthii* (Torr. & A. Gray) Lassetter & C.R. Gunn {*Vicia leavenworthii* Torr. & A. Gray}	Leavenworth's vetch
Vicia ludoviciana Nutt. subsp. *ludoviciana*	deer pea vetch
Vicia sativa L. subsp. *nigra* (L.) Ehrh. {*Vicia angustifolia* L.}	common vetch
Vicia villosa Roth subsp. *varia* (Host) Corb.	winter vetch

Fagaceae	**Oak Family**
Quercus buckleyi Nixon & Dorr {*Quercus texana* Buckl.}	Texas red oak, Spanish oak, rock oak
Quercus fusiformis Small	Plateau live oak, Escarpment live oak, scrub live oak
Quercus macrocarpa Michx.	bur oak, mossy-cup oak, prairie oak, mossy-overcup oak
Quercus marilandica Muenchh.	blackjack oak, blackjack, barren oak, Jack oak, black oak
Quercus muehlenbergii Engelm.	chinquapin oak, chinkapin oak, chestnut oak
Quercus shumardii Buckley	Shumard's oak, Shumard's red oak, red oak
Quercus sinuata Walter var. *breviloba* (Torr.) C.H. Mull.	Bigelow's oak, scrub oak, shin oak, scaly-bark oak

DIVISION Family Species {Synonym}	**Common Names**
Quercus stellata Wangenh.	post oak, iron oak, cross oak

Fumariaceae	**Fumitory Family**
Corydalis curvisiliqua Engelm.	scrambled eggs

Garryaceae	**Silktassel Family**
Garrya ovata Benth. subsp. *lindheimeri* Torr.	Lindheimer's silktassel, Mexican silktassel

Gentianaceae	**Gentian Family**
Centaurium beyrichii (Torr. & A. Gray) B.L. Rob.	rock centaury, mountain-pink
Centaurium floribundum (Benth.) B.L. Rob.	June centaury
Centaurium texense (Griseb.) Fernald	Texas centaury, Lady Bird's centaury
Eustoma russellianum (Hook.) G. Don {*Eustoma grandiflorum* (Raf.) Shinners}	bluebell gentain, bluebells
Sabatia campestris Nutt.	prairie rose gentian

Geraniaceae	**Geranium Family**
Erodium cicutarium (L.) L'Her. ex Aiton	filaree, pin-clover
Erodium texanum A. Gray	stork's-bill
Geranium carolinianum L.	crane's-bill, wild geranium
Geranium texanum (Trel.) A. Heller	Texas geranium

Haloragaceae	**Water-milfoil Family**
Myriophyllum heterophyllum Michx.	water-milfoil

Hippocastanaceae	**Buckeye Family**
Aesculus arguta Buckley {*Aesculus glabra* Willd. var. *arguta* (Buckley) B.L. Rob.}	Texas buckeye, white buckeye, western buckeye

Hydrophyllaceae	**Waterleaf Family**
Nama hispidum A. Gray	sandbells
Nemophila phacelioides Nutt.	baby blue-eyes
Phacelia congesta Hook.	blue-curls

Juglandaceae	**Walnut Family**
Carya illinoinensis (Wangenh.) K. Koch	pecan, nogal morado
Juglans major (Torr.) A. Heller	Arizona walnut, Arizona black walnut
Juglans microcarpa Berland.	Texas walnut, little walnut, Texas black walnut
Juglans nigra L.	black walnut

Krameriaceae	**Ratany Family**
Krameria lanceolata Torr.	trailing ratany

Lamiaceae	**Mint Family**
Hedeoma acinoides Scheele	slender hedeoma, annual pennyroyal
Hedeoma drummondii Benth.	Drummond's hedeoma
Hedeoma reverchonii (A. Gray) A. Gray var. *reverchonii*	rock hedeoma, mock pennyroyal
Lamium amplexicaule L.	henbit
Lycopus americanus Muhl. ex W. Barton	American bugleweed, water-horehound
Lycopus rubellus Moench	water-horehound, Arkansas bugleweed

DIVISION Family Species {Synonym}	Common Names
Marrubium vulgare L.	common horehound
Mentha x *piperita* L.	peppermint
Monarda citriodora Cerv. ex Lag.	lemon beebalm, purple horsemint
Monarda punctata L. var. *intermedia* (E.M. McClint. & Epling) Waterf.	spotted beebalm
Physostegia intermedia (Nutt.) Engelm. & A. Gray	intermediate lion's-heart, false dragon-head
Salvia azurea Michx. ex Lam. var. *grandiflora* Benth.	giant blue sage
Salvia engelmannii A. Gray	Engelmann's sage
Salvia farinacea Benth.	mealy sage
Salvia roemeriana Scheele	cedar sage
Salvia texana (Scheele) Torr.	Texas sage
Scutellaria drummondii Benth. var. *drummondii*	Drummond's skullcap
Scutellaria ovata Hill subsp. *bracteata* (Benth.) Elping	egg-leaf skullcap, tuber skullcap
Scutellaria wrightii A. Gray	Wright's skullcap, bushy skullcap
Stachys crenata Raf.	shade betony
Teucrium canadense L.	American germander
Teucrium laciniatum Torr.	cut-leaf germander
Trichostema brachiatum L.	flux-weed
Warnockia scutellarioides (Engelm. & A. Gray) M.W. Truner {*Brazoria scutellarioides* Engelm. & A. Gray}	prairie brazoria

Lauraceae	**Laurel Family**
Lindera benzoin (L.) Blume var. *pubescens* (E.J. Palmer & Steyerm.) Rehder	spicebush

Lentibulariaceae	**Bladderwort Family**
Utricularia gibba L.	cone-spur bladderwort

Linaceae	**Flax Family**
Linum grandiflorum Desf.	flowering flax
Linum imbricatum (Raf.) Shinners	tufted flax
Linum pratense (J.B. Norton) Small	meadow flax
Linum rigidum Pursh var. *berlandieri* (Hook.) Torr. & A. Gray {*Linum berlandieri* Hook. var. *berlandieri*}	Berlandier's flax
Linum rigidum Pursh var. *rigidum*	stiff-stem flax
Linum rupestre (A. Gray) Engelm. ex A. Gray	rock flax

Loasaceae	**Stick-leaf Family**
Mentzelia oligosperma Nutt. ex Sims	stick-leaf

Loganiaceae	**Logania Family**
Mitreola petiolata (J.F. Gmel.) Torr. & A. Gray {*Cynoctonum mitreola* (L.) Britton}	lax hornpod, miterwort

Lythraceae	**Loosestrife Family**
Ammannia coccinea Rottb.	purple ammannia, toothcup
Lagerstroemia indica L.	common crape-myrtle, crespon
Lythrum californicum Torr. & A. Gray	California loosestrife
Rotala ramosior (L.) Koehne	toothcup

Malvaceae	**Mallow Family**

DIVISION Family Species {Synonym}	**Common Names**
Abutilon fruticosum Guill. & Perr. {*Abutilon incanum* (Link) Sweet}	Indian-mallow
Callirhoe involucrata (Torr.) A. Gray	winecup
Callirhoe pedata (Nutt. ex Hook.) A. Gray {*Callirhoe digitata* Nutt. var. *stipulata* Waterfall}	finger poppy-mallow, standing winecup
Malva neglecta Wallr.	common mallow, cheeses
Malvaviscus arboreus Dill. ex Cav. var. *drummondii* (Torr. & A. Gray) Schery {*Malvaviscus drummondii* Torr. & A. Gray}	Drummond wax-mallow, turk's cap, Texas-mallow
Modiola caroliniana (L.) G. Don	Carolina modiola
Rhynchosida physocalyx (A. Gray) Fryxell {*Sida physocalyx* A. Gray}	spear-leaf sida, buffpetal
Sida abutifolia P. Mill. {*Sida filicaulis* Torr. & A. Gray}	spreading sida
Sida spinosa L.	prickly sida
Sphaeralcea coccinea (Nutt.) Rydb.	scarlet globe-mallow

Meliaceae	**Mahogany Family**
Melia azedarach L.	China-berry, pride-of-India, cavelon, China-tree

Menispermaceae	**Moonseed Family**
Cocculus carolinus (L.) DC.	Carolina snailseed

Molluginaceae	**Carpetweed Family**
Mollugo verticillata L.	green carpetweed, Indian-chickweed

Moraceae	**Mulberry Family**
Ficus carica L.	common fig, fig tree, higuera
Maclura pomifera (Raf.) C.K. Schneid.	bois d'arc, horse-apple, Osage orange, bow-wood
Morus alba L.	white mulberry, Russian mulberry, silkworm mulberry
Morus microphylla Buckley	Texas mulberry, Mexican mulberry, mountain mulberry
Morus rubra L.	red mulberry, moral

Nyctaginaceae	**Four-o'clock Family**
Mirabilis albida (Walter) Heimerl	white four-o'clock
Mirabilis latifolia (A. Gray) Diggs, Lipscomb, and O'Kennon {*Mirabilis dumetorum* Shinners}	broad-leaved four-o'clock
Mirabilis linearis (Pursh) Heimerl	linear-leaf four-o'clock
Mirabilis nyctaginea (Michx.) MacMill.	wild four-o'clock

Oleaceae	**Olive Family**
Forestiera pubescens Nutt. var. *glabrifolia* Shinners	smooth-leaf forestiera
Forestiera pubescens Nutt. var. *pubescens*	elbow-bush, spring-herald, stretch-berry
Fraxinus americana L.	white ash, fresno
Fraxinus pennsylvanica Marshall	green ash, red ash
Fraxinus texensis (A. Gray) Sarg. {*Fraxinus americana* L. var. *texensis* A. Gray}	Texas white ash, Texas ash
Jasminum nudiflorum Lindley	winter jasmine

DIVISION Family Species {Synonym}	Common Names
Ligustrum lucidum W.T. Aiton	glossy privet, Chinese privet, wax-leaf privet, tree privet
Ligustrum sinense L.	Chinese privet
Syringa persica L.	Persian lilac

Onagraceae	**Evening Primrose Family**
Calylophus berlandieri Spach subsp. *berlandieri* {*Calylophus drummondianus* Spach subsp. *berlandieri* (Spach) Towner & Raven}	half-shrub sundrops, Drummond's sundrops, Berlandier's evening-primrose
Calylophus berlandieri Spach subsp. *pinifolius* (Engelm. & A. Gray) Towner {*Calylophus drummondianus* Spach} {*Calylophus serrulatus* (Nutt.) P.H. Raven var. *spinulosus* (Nutt. ex Torr. & A. Gray) Shinners}	Berlandier's evening-primrose, square-bud day-primrose
Gaura brachycarpa Small	plains gaura
Gaura coccinea Nutt. ex Pursh	scarlet gaura
Gaura drummondii (Spach) Torr. & A. Gray	sweet gaura, scented gaura
Gaura longiflora Spach {*Gaura filiformis* Small}	tall gaura
Gaura parviflora Dougl. ex Lehm.	lizard-tail gaura
Gaura sinuata Nutt. ex Ser.	wavy-leaf gaura
Gaura suffulta Engelm. ex A. Gray	wild honeysuckle
Ludwigia octovalvis (Jacq.) P.H. Raven	shrubby water-primrose
Ludwigia palustris (L.) Elliott	marsh-purslane
Ludwigia repens J.R. Forst.	round-leaf seedbox, creeping primrose-willow
Oenothera jamesii Torr. & A. Gray	river primrose
Oenothera laciniata Hill	cut-leaf evening-primrose
Oenothera macrocarpa Nutt. subsp. *macrocarpa* {*Oenothera missouriensis* Sims}	flutter-mill
Oenothera rhombipetala Nutt. ex Torr. & A. Gray	four-point evening-primrose
Oenothera speciosa Nutt.	showy primrose, buttercup
Oenothera triloba Nutt.	stemless evening-primrose
Stenosiphon linifolius (Nutt. ex E. James) Heynh.	false gaura

Oxalidaceae	**Wood-sorrel Family**
Oxalis drummondii A. Gray	purple wood-sorrel
Oxalis stricta L. {*Oxalis dillenii* Jacq.}	sheep-showers, yellow wood-sorrel
Oxalis corniculata L.	creeping ladies'-sorrel, jocoyote

Papaveraceae	**Poppy Family**
Argemone albiflora Hornem. subsp. *texana* G.B. Ownbey	white prickly-poppy
Argemone aurantiaca G.B. Ownbey	prickly-poppy

Passifloraceae	**Passion-flower Family**
Passiflora affinis Engelm.	bracted passion-flower
Passiflora lutea L.	yellow passion-flower

Pedaliaceae	**Sesame Family**
Proboscidea louisianica (Mill.) Thell.	devil's claw, unicorn-plant

DIVISION Family Species {Synonym}	**Common Names**
Phrymaceae	**Lopseed Family**
Phryma leptostachya L.	lopseed

Phytolaccaceae	**Pokeweed Family**
Phytolacca americana L.	pokeweed
Rivina humilis L.	pigeon-berry

Plantaginaceae	**Plantain Family**
Plantago helleri Small	cedar plantain
Plantago patagonica Jacq. var. *gnaphalioides* (Nutt.) A. Gray	bristle-bract plantain
Plantago patagonica Jacq. var. *spinulosa* (Decne.) A. Gray	bristle-bract plantain
Plantago rhodosperma Decne.	red-seed plantain, tallow-weed
Plantago virginica L.	pale-seed plantain, dwarf plantain, hoary plantain
Plantago wrightiana Decne.	Wright's plantain

Platanaceae	**Planetree Family**
Platanus occidentalis L.	American sycamore

Polemoniaceae	**Phlox Family**
Gilia incisa Bentham	split-leaf gilia
Ipomopsis rubra (L.) Wherry	standing cypress
Phlox drummondii Hook. subsp. *drummondii*	Drummond's phlox
Phlox pilosa L. subsp. *pilosa*	downy phlox
Phlox pilosa L. subsp. *riparia* Wherry	prairie phlox
Phlox roemeriana Scheele	gold-eye phlox

Polygalaceae	**Milkwort Family**
Polygala alba Nutt.	white milkwort
Polygala incarnata L.	pink milkwort
Polygala lindheimeri A. Gray var. *parviflora* Wheelock	purple milkwort, rock milkwort
Polygala verticillata L.	whorled milkwort

Polygonaceae	**Knotweed Family**
Eriogonum annuum Nutt.	annual wild buckwheat
Eriogonum longifolium Nutt.	long-leaf wild buckwheat
Polygonum aviculare L.	prostrate knotweed
Polygonum densiflorum Meisn. {*Persicaria densiflora* (Meisn.) Moldenke}	snout smartweed
Polygonum lapathifolium L.	willow smartweed
Polygonum punctatum Elliott	water smartweed, dotted smartweed
Polygonum ramosissimum Michx.	bushy knotweed
Rumex crispus L.	curly dock
Rumex hastatulus Baldwin	heart-wing sorrel
Rumex pulcher L.	fiddle dock

Portulacaceae	**Purslane Family**
Claytonia viginica L.	Virginia spring-beauty
Portulaca oleracea L.	common purslane
Portulaca pilosa L. {*Portulaca mundula* I.M. Johnston}	chisme, shaggy portulaca

DIVISION Family Species {Synonym}	Common Names
Primulaceae	**Primrose Family**
Anagallis arvensis L.	scarlet pimpernel, poorman's weatherglass
Samolus ebracteatus Kunth subsp. *cuneatus* (Small) R. Knuth {*Samolus cuneatus* Small}	limerock brookweed
Samolus valerandi L. subsp. *parviflorus* (Raf.) Hulten {*Samolus parviflorus* Raf.}	thin-leaf brookweed

Punicaceae	**Pomegranate Family**
Punica granatum L.	pomegranate

Rafflesiaceae	**Rafflesia Family**
Pilostyles thurberi A. Gray {*Pilostyles covillei* Rose}	Thurber's pilostyles

Ranunculaceae	**Crowfoot Family**
Anemone berlandieri Pritz. {*Anemone heterophylla* Nutt. ex Torr. & A. Gray}	wind-flower, ten-petal anemone
Aquilegia canadensis L.	common columbine
Clematis drummondii Torr. & A. Gray	Texas virgin's-bower, old-man's-beard
Clematis pitcheri Torr. & A. Gray	purple leather-flower, bluebell
Clematis texensis Buckley	scarlet clematis, red leather-flower
Delphinium carolinianum Walter subsp. *vimineum* (D. Don) M.J. Warnock {*Delphinium vimineum* D. Don}	pinewoods larkspur, blue larkspur
Delphinium carolinianum Walter subsp. *virescens* (Nutt.) R.E. Brooks {*Delphinium virescens* Nutt. var. *macroceratilis* (Rydb.) Cory}	prairie larkspur, plains larkspur
Ranunculus hispidus Michx. var. *nitidus* (Chapm.) T. Duncan	bristly buttercup, marsh buttercup
Ranunculus macranthus Scheele	large buttercup
Ranunculus sceleratus L.	blister buttercup

Rhamnaceae	**Buckthorn Family**
Berchemia scandens (Hill) K. Koch	Alabama supple-jack, rattanvine
Ceanothus herbaceus Raf.	redroot, New Jersey tea, fuzzy ceanothus
Frangula caroliniana (Walter) A. Gray {*Rhamnus caroliniana* Walter}	Carolina buckthorn, Indian-cherry, yellowwood
Ziziphus zizyphus (L.) H. Karst. {*Ziziphus jujuba* Mill.}	jujube, Japanese-apple, Chinese-date

Rosaceae	**Rose Family**
Crataegus crus-galli L.	cockspur hawthorn
Geum canadense Jacq. var. *camporum* (Rydb.) Fernald & Weath.	plains white avens
Photinia serratifolia (Desf.) Kalkman {*Photinia serrulata* Lindl.}	red-tipped photinia
Prunus mexicana S. Watson	Mexican plum, big-tree plum
Prunus munsoniana W. Wight & Hedrick	wildgoose plum, Munson's plum
Prunus persica (L.) Batsch	peach, durazno
Prunus rivularis Scheele	thicket plum, hog plum, creek plum

DIVISION Family Species {Synonym}	**Common Names**
Prunus serotina Ehrend. var. *eximia* (Small) Little	Escarpment blackcherry
Prunus umbellata Elliott	flatwood plum
Pyracantha koidzumii (Hayata) Rehder	fire-thorn
Pyrus calleryana Decne.	Bradford pear, Callery pear
Pyrus communis L.	common pear, pera
Rosa eglanteria L.	sweet brier rose, sweet-brier
Rosa multiflora Thunb. ex Murr.	Japanese rose, multiflora rose
Rosa sp.	antique rose
Rubus aboriginum Rydb.	aboriginal dewberry
Rubus bifrons Vest ex Tratt.	twice-leafed blackberry
Rubus trivialis Michx. {*Rubus riograndis* L. Bailey}	southern dewberry, zarzamora

Rubiaceae	**Madder Family**
Cephalanthus occidentalis L.	common buttonbush, honey-balls, globeflower
Diodia teres Walter	poor-Joe, buttonweed
Galium aparine L.	catchweed bedstraw
Galium circaezans Michx.	woods bedstraw
Galium pilosum Aiton	hairy bedstraw
Galium texense A. Gray	Texas bedstraw
Galium virgatum Nutt.	southwest bedstraw
Hedyotis nigricans (Lam.) Fosberg	prairie bluets
Sherardia arvensis L.	spurwort, field-madder

Rutaceae	**Citrus Family**
Ptelea trifoliata L. subsp. *angustifolia* (Benth.) V.L. Bailey var. *persicifolia* (Greene) V.L. Bailey	narrow-leaf hoptree, wafer-ash, skunkbush
Ptelea trifoliata L. subsp. *trifoliata* var. *mollis* Torr. & A. Gray	woolly hoptree, wafer-ash, skunkbush
Zanthoxylum clava-herculis L.	Hercules' club, southern prickly-ash, tickletongue, pepperbark
Zanthoxylum hirsutum Buckley	prickly-ash, tickle-tongue, toothache tree

Salicaceae	**Willow Family**
Populus deltoides Bartr. ex Marsh. subsp. *deltoides*	eastern cottonwood, alamo
Salix nigra Marsh.	black willow

Sapindaceae	**Soap-berry Family**
Cardiospermum halicacabum L.	common balloonvine
Sapindus saponaria L. var. *drummondii* (Hook. & Arn.) L.D. Benson	western soapberry, wild Chinaberry, jaboncillo
Ungnadia speciosa Endl.	Mexican-buckeye

Sapotaceae	**Sapodilla Family**
Sideroxylon lanuginosum Michx. subsp. *oblongifolium* (Nutt.) T.D. Penn. {*Bumelia lanuginosa* (Michx.) Pers.}	chittamwood, coma, gum bumelia, woolly-buckthorn, gum-elastic

Scrophulariaceae	**Figwort Family**
Agalinis densiflora (Benth.) S.F. Blake {*Tomanthera densiflora* (Benth.) Pennell}	fine-leaf gerardia

DIVISION Family Species {Synonym}	Common Names
Agalinis heterophylla (Nutt.) Small ex Britton	prairie agalinis
Bacopa monnieri (L.) Pennell	coastal water-hyssop
Buchnera floridana Grand.	bluehearts
Castilleja indivisa Engelm.	Texas paintbrush
Castilleja purpurea (Nutt.) G. Don var. *lindheimeri* (A. Gray) Shinners	prairie paintbrush
Leucospora multifida (Michx.) Nutt.	narrow-leaf conobea
Maurandya antirrhiniflora Humb. & Bonpl. ex Willd.	snapdragon vine
Mecardonia procumbens (P. Mill.) Small {*Mecardonia vandellioides* (Kunth) Pennell}	prostrate mecardonia
Nuttallanthus texanus (Scheele) D.A. Sutton	Texas toad-flax
Penstemon cobaea Nutt.	wild fox-glove
Penstemon laxiflorus Pennell	loose-flowered penstemon
Verbascum thapsus L.	common mullein
Veronica anagallis-aquatica L.	water speedwell, brook-pimpernel
Veronica americana Schwein. ex Benth.	American brooklime
Veronica arvensis L.	common speedwell
Veronica peregrina L. var. *xalapensis* (Kunth) Pennell	jalapa speedwell

Simaroubaceae	**Quassia Family**
Ailanthus altissima (Mill.) Swingle	tree-of-heaven, copaltree

Solanaceae	**Nightshade Family**
Bouchetia erecta DC.	erect bouchetia
Chamaesaracha edwardsiana Averett	Plateau false nightshade
Chamaesaracha sordida (Dunal) A. Gray	hairy false nightshade
Datura inoxia Mill.	Indian-apple, Jimson-weed, thorn-apple
Physalis angulata L.	cut-leaf ground-cherry, southwest ground-cherry
Physalis cinerascens (Dunal) Hitchc. {*Physalis viscosa* L. var. *cinerascens* (Dunal) Waterfall}	yellow ground-cherry, beach ground-cherry
Physalis heterophylla Nees	clammy ground-cherry
Physalis longifolia Nutt. var. *longifolia* {*Physalis virginiana* P. Mill. var. *sonorae* (Torr.) Waterfall}	common ground-cherry
Solanum carolinense L.	Carolina horse-nettle
Solanum dimidiatum Raf.	western horse-nettle
Solanum elaeagnifolium Cav.	silver-leaf nightshade
Solanum ptychanthum Dunal {*Solanum americanum* Mill.}	American nightshade, hierba mora negra
Solanum rostratum Dunal	buffalo-bur, mala mujer
Solanum triquetrum Cav.	Texas nightshade

Styracaceae	**Storax Family**
Styrax platanifolius Engelm. ex Torr. subsp. *platanifolius*	sycamore-leaf snowbell

Tamaricaceae	**Tamarisk Family**
Tamarix chinensis Lour. {*Tamarix pentandra* Pallas}	Chinese tamarisk
Tamarix ramosissima Ledeb.	salt-cedar

Ulmaceae	**Elm Family**
Celtis laevigata Willd. var. *laevigata*	Texas sugarberry

DIVISION Family Species {Synonym}	Common Names
Celtis laevigata Willd. var. *reticulata* Torr. {*Celtis reticulata* Torr.}	net-leaf hackberry, palo blanco
Celtis laevigata Willd. var. *texana* (Scheele) Sarg.	Texas hackberry
Ulmus americana L.	American elm, white elm
Ulmus crassifolia Nutt.	cedar elm
Ulmus rubra Muhl.	slippery elm, red elm

Urticaceae	**Nettle Family**
Boehmeria cylindrica (L.) Sw.	bog-hemp, false nettle
Parietaria pensylvanica Muhl. ex Willd. var. *obtusa* (Rydb. ex Small) Shinners	Pennsylvania pellitory
Parietaria pensylvanica Muhl. ex Willd. var. *pensylvanica*	hammerwort
Urtica chamaedryoides Pursh	stinging nettle, ortiguilla

Valerianaceae	**Valerian Family**
Valerianella amarella (Lindh. ex Engelm.) Krok	hairy cornsalad
Valerianella radiata (L.) Dufr. forma *parviflora* (Dyal) Eff.Ware	beaked cornsalad
Valerianella radiata (L.) Dufr. forma *radiata*	beaked cornsalad

Verbenaceae	**Vervain Family**
Callicarpa americana L.	American beauty-berry, French-mulberry, sourbush, bunchberry, foxberry, turkey-berry
Glandularia bipinnatifida (Nutt.) Nutt. {*Verbena bipinnatifida* Nutt.}	Dakota vervain, prairie verbena
Glandularia pumila (Rydb.) Umber {*Verbena pumila* Rydb.}	pink vervain
Lantana camara L.	West Indian lantana, large-leaf lantana
Lantana urticoides Hayek {*Lantana horrida* H.B.K.}	Texas lantana, calico-bush, common lantana, bunchberry
Lippia nodiflora (L.) Michx. {*Phyla nodiflora* (L.) Greene} {*Phyla incisa* Small}	Texas frog-fruit
Verbena brasiliensis Vell.	Brazilian vervain
Verbena halei Small	slender vervain, Texas vervain
Verbena neomexicana (A. Gray) Small var. *neomexicana*	hillside vervain
Verbena scabra Vahl	harsh vervain
Verbena xutha Lehm.	coarse vervain, Gulf vervain
Vitex agnus-castus L. var. *agnus-castus*	common chaste-tree, Indian-spice, wild-lavender, hemptree, monk's pepper-tree, sagetree

Violaceae	**Violet Family**
Hybanthus verticillatus (Ort.) Baill.	nodding green-violet
Viola missouriensis Greene	Missouri violet
Viola sororia Willd.	sister violet, bayou violet, downy blue violet

Viscaceae	**Mistletoe Family**
Phoradendron tomentosum (DC.) Engelm. ex A. Gray	mistletoe, Christmas mistletoe, hairy mistletoe

DIVISION Family Species {Synonym} | **Common Names**

Vitaceae	**Grape Family**
Ampelopsis arborea (L.) Koehne	pepper-vine
Ampelopsis cordata Michx.	heart-leaf ampelopsis
Cissus incisa Des Moul.	cow-itch, ivy treebine
Parthenocissus heptaphylla (Buckley) Britton ex Small	seven-leaf creeper
Parthenocissus quinquefolia (L.) Planch.	Virginia creeper, woodbine, American ivy
Vitis cinerea (Engelm.) Millardet var. *helleri* (L.H. Bailey) M.O. Moore {*Vitis berlandieri* Planch.}	winter grape, Spanish grape, round-leaf grape
Vitis monticola Buckley	sweet mountain grape
Vitis mustangensis Buckley	mustang grape
Vitis vulpina L.	fox grape

Zygophyllaceae	**Caltrop Family**
Kallstroemia parviflora Norton	warty caltrop
Tribulus terrestris L.	goathead, punctureweed

MAGNOIOPHYTA-MONOCOTYLEDONAE | **MONOCOTS**

Agavaceae	**Yucca or Agave Family**
Nolina lindheimeriana (Scheele) S. Watson	devil's shoestring, ribbon-grass
Nolina texana S. Watson	sacahuista, bunch-grass
Yucca arkansana Trel.	Arkansas yucca
Yucca constricta Buckley	Buckley's yucca
Yucca pallida McKelvey	pale yucca, pale-leaf yucca
Yucca rupicola Scheele	Texas yucca, twist-leaf yucca
Yucca treculeana Carr.	Spanish-dagger, Trecul's yucca, Spanish-bayonet, Don Quixote's lance, palma pita, Texas-bayonet

Alismataceae	**Water Plantain Family**
Echinodorus berteroi (Spreng.) Fassett {*Echinodorus rostratus* (Nutt.) Engelm. *ex* A. Gray}	burhead
Sagittaria montevidensis Cham. & Schlecht. subsp. *calycina* (Engelm.) Bogin	giant arrowhead
Sagittaria platyphylla (Engelm.) J.G. Sm.	delta arrowhead

Araceae	**Arum Family**
Arisaema dracontium (L.) Schott	green-dragon
Xanthosoma sagittifolium (L.) Schott	elephant's ear

Commelinaceae	**Spiderwort Family**
Commelina erecta L. var. *erecta*	erect dayflower, hierba de pollo
Tinantia anomala (Torr.) C.B. Clarke {*Commelinantia anomala* (Torr.) Woodson}	false dayflower, widow's-tears
Tradescantia edwardsiana Tharp	Plateau spiderwort
Tradescantia gigantea Rose	giant spiderwort
Tradescantia humilis Rose	Texas spiderwort
Tradescantia occidentalis (Britton) Smyth	prairie spiderwort, western spiderwort

Cyperaceae	**Sedge Family**

DIVISION Family Species {Synonym}	Common Names
Carex blanda Dewey	charming caric sedge
Carex bulbostylis Mack. {*Carex amphibola* Steud.}	globose caric sedge
Carex edwardsiana E.L. Bridges & Orzell {*Carex oligocarpa* Schkuhr ex Willd.}	Edwards Plateau caric sedge
Carex emoryi Dewey	William Emory's caric sedge
Carex microdonta Torr. & Hook.	small-tooth caric sedge
Carex muehlenbergii Schkuhr ex Willd.	Muhlenberg's caric sedge
Carex muehlenbergii Schkuhr var. *enervis* Boott {*Carex onusta* Mack.}	Muhlenberg's veinless caric sedge
Carex planostachys Kunze	cedar caric sedge
Carex retroflexa Muhl. ex Willd.	reflexed-fruit caric sedge
Carex tetrastachya Scheele	four-angle caric sedge
Cladium mariscus (L.) J. Pohl subsp. *jamaicense* (Crantz) Kuk.	Jamaican saw-grass
Cyperus acuminatus Torr. & Hook. ex Torr.	taper-leaf flat sedge
Cyperus lupulinus (Spreng.) Marcks {*Cyperus filiculmis* Vahl}	slender flat sedge
Cyperus odoratus L.	fragrant flat sedge
Cyperus retroflexus Buckley {*Cyperus uniflorus* Torr. & Hook.}	one-flower flat sedge
Cyperus squarrosus L.	bearded flat sedge
Cyperus strigosus L.	false nut-grass
Eleocharis acutisquamata Buckley	sharp-scale spike-rush
Eleocharis montevidensis Kunth	spike-rush
Eleocharis palustris (L.) Roem. & Schult. {*Eleocharis macrostachya* Britton}	large-spike spike-rush
Eleocharis parvula (Roem. & Schult.) Link ex Bluff, Nees & Schauer	dwarf spike-rush
Eleocharis quadrangulata (Michx.) Roem. & Schult.	square-stem spike-rush
Fimbristylis puberula (Michx.) Vahl var. *puberula*	hairy fimbristylis
Fimbristylis vahlii (Lam.) Link.	Vahl's fimbristylis
Fuirena simplex Vahl	umbrella sedge, western umbrella-grass
Schoenoplectus saximontanus (Fernald) J. Raynal {*Scirpus saximontanus* Fernald}	Rocky Mountain bulrush
Scirpus pendulus Muhl.	bulrush
Scleria ciliata Michx.	fringed nut-rush

Hydrocharitaceae	**Frog's-bit Family**
Najas guadalupensis (Spreng.) Magnus	common water-nymph

Iridaceae	**Iris Family**
Iris sp.	flag, fleur-de-lis, iris
Nemastylis geminiflora Nutt.	prairie celestial
Sisyrinchium chilense Hook. {*Sisyrinchium ensigerum* Bickn.}	sword-leaf blue-eyed-grass
Sisyrinchium pruinosum E.P. Bicknell	dotted blue-eyed-grass

Juncaceae	**Rush Family**
Juncus effusus L. var. *solutus* Fernald & Wiegand	common rush, soft rush
Juncus interior Wiegand	inland rush
Juncus marginatus Rostk.	grass-leaf rush
Juncus tenuis Willd.	slender rush, poverty rush

DIVISION Family Species {Synonym}	Common Names
Juncus texanus (Engelm.) Coville	Texas rush
Juncus torreyi Coville	Torrey's rush

Liliaceae	**Lily Family**
Allium ampeloprasum L. {*Allium porrum* L.}	wild leek
Allium canadense L. var. *canadense*	Canada garlic, wild garlic
Allium canadense L. var. *fraseri* Ownbey	wild onion
Allium drummondii Regel	Drummond's wild onion
Androstephium coeruleum (Scheele) Greene	blue funnel-lily
Camassia scilloides (Raf.) Cory	wild-hyacinth, eastern camass
Cooperia drummondii Herb.	cebolleta, rain-lily
Cooperia pedunculata Herb.	giant rain-lily, prairie rain-lily
Erythronium albidum Nutt.	white dog-tooth-violet
Erythronium mesochoreum Knerr	dog-tooth-violet
Muscari neglectum Guss. ex Ten. {*Muscari racemosum* (L.) Lam. & DC.}	starch grape-hyacinth
Nothoscordum bivalve (L.) Britton	crow-poison, yellow false garlic
Zigadenus nuttallii (A. Gray) S. Watson	Nuttall's death-camass

Orchidaceae	**Orchid Family**
Corallorrhiza wisteriana Conrad	spring coralroot
Hexalectris nitida L.O. Williams	shining hexalectris
Hexalectris spicata (Walter) Barnhart var. *arizonica* (S. Watson) Catling & V.S. Engel	crested-coralroot
Spiranthes cernua (L.) Rich.	nodding ladies'-tresses

Poaceae	**Grass Family**
Aegilops cylindrica Host	jointed goat grass
Andropogon gerardii Vitman subsp. *gerardii*	big bluestem, turkeyfoot
Andropogon glomeratus (Walter) B.S.P.	bushy bluestem, bushy beard grass
Aristida oligantha Michx.	oldfield three-awn, prairie three-awn
Aristida purpurea Nutt. var. *longiseta* (Steud.) Vasey {*Aristida longiseta* Steud.}	red three-awn, long-awned aristida, long-awned three-awn
Aristida purpurea Nutt. var. *nealleyi* (Vasey) Allred {*Aristida purpurea* Nutt. var. *glauca* (Nees) A.& N. Holmgren} {*Aristida glauca* (Nees) Walp.}	blue three-awn
Aristida purpurea Nutt. var. *purpurea*	purple three-awn, purple needle grass
Aristida purpurea Nutt. var. *wrightii* (Nash) Allred {*Aristida wrightii* Nash}	Wright's three-awn, Wright's triple-awn grass
Arundo donax L.	giant reed
Avena fatua L.	wild oats
Avena sativa L.	common oats, cultivated oats
Bothriochloa barbinodis (Lag.) Herter var. *perforata* (Trin. ex Fourn.) Gould	pinhole bluestem, pinhole beard grass
Bothriochloa ischaemum (L.) Keng var. *songarica* (Rupr. ex Fisch. & C.A. Mey.) Celarier & Harlan	King Ranch bluestem, KR bluestem

DIVISION Family Species {Synonym}	**Common Names**
Bothriochloa laguroides (DC.) Herter subsp. *torreyana* (Steud.) Allred & Gould {*Bothriochloa saccharoides* (Sw.) Rydb. var. *torreyana* (Steud.) Gould} {*Bothriochloa longipaniculata* (Gould) Allred & Gould}	silver bluestem, silver beard grass
Bouteloua curtipendula (Michx.) Torr. var. *curtipendula*	side-oats grama
Bouteloua hirsuta Lag.	hairy grama
Bouteloua pectinata Feath.	tall grama
Bouteloua rigidiseta (Steud.) Hitchc.	Texas grama, mesquite grass
Bouteloua trifida Thurb.	red grama, threeawn grama
Bromus catharticus Vahl {*Bromus unioloides* Kunth}	rescue grass, rescue brome
Bromus japonicus Thunb. ex Murray	Japanese brome, Japanese chess, spreading brome
Bromus pubescens Muhl. ex Willd. {*Bromus purgans* L.}	downy brome grass
Bromus tectorum L. var. *tectorum*	cheat grass, downy brome
Buchloe dactyloides (Nutt.) Engelm.	buffalo grass
Cenchrus spinifex Cav. {*Cenchrus incertus* M.A. Curtis} {*Cenchrus carolinianus* Walter }	common sandbur, grassbur
Chasmanthium latifolium (Michx.) H.O. Yates	wild oats, creek-oats
Chloris cucullata Bisch.	hooded windmill grass
Chloris subdolichostachya Muell.Hal. {*Chloris latisquamea* Nash}	short-spike windmill grass
Chloris verticillata Nutt.	tumble windmill grass, windmill finger grass
Chloris virgata Sw.	feather finger grass, showy chloris
Coelorachis cylindrica (Michx.) Nash	Carolina joint-tail
Cynodon dactylon (L.) Pers.	Bermuda grass, Bahama grass
Desmazeria rigida (L.) Tutin {*Catapodium rigidum* (L.) C.E. Hubb. ex. Dony} {*Scleropoa rigida* (L.) Griseb.}	catapodium
Dichanthium annulatum (Forssk.) Stapf	Kleberg bluestem
Digitaria ciliaris (Retz.) Koeler	southern crab grass
Digitaria cognata (Schult.) Pilg. subsp. *pubiflora* (Vasey) Wipff {*Leptoloma cognatum* (Schult.) Chase}	western witch grass
Echinochloa colona (L.) Link	jungle-rice, shama-millet
Echinochloa crus-galli (L.) P. Beauv.	common barnyard grass
Eleusine indica (L.) Gaertn.	goose grass, yard grass
Elymus canadensis L.	Canada wild rye, nodding wild rye
Elymus virginicus L.	Virginia wild rye
Eragrostis barrelieri Daveau	Mediterranean love grass
Eragrostis cilianensis (All.) Vagnalo ex Janch.	stink grass
Eragrostis curtipedicellata Buckley	gummy love grass, short-stalked love grass
Eragrostis hirsuta (Michx.) Nees	big-top love grass, stout love grass
Eragrostis intermedia Hitchc.	plains love grass
Eragrostis pilosa (L.) P. Beauv.	India love grass
Eragrostis secundiflora J. Presl subsp. *oxylepis* (Torr.) S.D. Koch	red love grass

DIVISION Family Species {Synonym}	**Common Names**
Eragrostis sessilispica Buckley	tumble love grass
Eragrostis spectabilis (Pursh) Steud.	purple love grass
Eragrostis superba J. Peyritsch	Wilmann's love grass
Eriochloa sericea (Scheele) Munro ex Vasey	Texas cup grass, silky cup grass
Erioneuron pilosum (Buckley) Nash	hairy tridens, hairy erioneuron
Festuca versuta Beal	Texas fescue
Glyceria striata (Lam.) Hitchc.	fowl manna grass, nerved manna grass
Hilaria belangeri (Steud.) Nash	common curly-mesquite
Hordeum pusillum Nutt.	little barley, mouse barley
Leersia virginica Willd.	white grass, Virginia cut grass
Leptochloa dubia (Kunth) Nees	green sprangletop, Texas crowfoot
Leptochloa mucronata (Michx.) Kunth {*Leptochloa filiformis* (Lam.) Beauv.}	red sprangletop, slender grass
Limnodea arkansana (Nutt.) L.H. Dewey	Ozark grass
Lolium perenne L. subsp. *multiflorum* (Lam.) Husnot	Italian rye grass
Lolium temulentum L.	darnel rye grass, poison darnel
Muhlenbergia capillaris (Lam.) Trin. {*Muhlenbergia expansa* (Poir.) Trin.}	hairy-awn muhly, gulf muhly
Muhlenbergia lindheimeri Hitchc.	Lindheimer's muhly
Muhlenbergia reverchonii Vasey & Scribn.	seep muhly, Reverchon's muhly
Muhlenbergia schreberi J.F. Gmel.	nimble-will, satin grass, Schreber's muhly
Nassella leucotricha (Trin. & Rupr.) Barkworth {*Stipa leucotricha* Trin. & Rupr.}	Texas wintergrass, spear grass, Texas needle grass
Panicum aciculare Desv. ex Poir. var. *aciculare* {*Dichanthelium aciculare* (Desv. ex Poir.) Gould & C.A. Clark}	panic grass, dichanthelium
Panicum acuminatum Sw. var. *acuminatum* {*Dichanthelium acuminatum* (Sw.) Gould & C.A. Clark var. *fasciculatum* (Torr.) Freckmann} {*Dichanthelium acuminatum* (Sw.) Gould & C.A. Clark var. *implicatum* (Scribn.) Gould & C.A. Clark}	woolly rosette grass, woolly panic
Panicum acuminatum Sw. var. *lindheimeri* (Nash) Lelong {*Dichanthelium acuminatum* (Sw.) Gould & C.A. Clark var. *lindheimeri* (Nash) Gould & C.A. Clark}	Lindheimer's rosette grass, Lindheimer's panic
Panicum capillare L.	common witchgrass
Panicum coloratum L.	Klein grass
Panicum depauperatum Muhl. {*Dichanthelium depauperatum* (Muhl.) Gould}	starved rosette grass
Panicum hallii Vasey var. *hallii*	Hall's panicum
Panicum hians Elliot	gaping panicum
Panicum obtusum Kunth	vine-mesquite
Panicum oligosanthes Schult. var. *oligosanthes*	rosette grass
Panicum oligosanthes Schult. var. *scribnerianum* (Nash) Gould {*Dichanthelium oligosanthes* (Schult.) Gould var. *scribnerianum* (Nash) Gould}	Scribner's rosette grass
Panicum pedicellatum Vasey {*Dichanthelium pedicellatum* (Vasey) Gould}	cedar rosette grass, cedar panic
Panicum sphaerocarpon Elliott {*Dichanthelium sphaerocarpon* (Elliott) Gould}	round-seed rosette grass, round-seed panic
Panicum virgatum L.	switch grass
Paspalum dilatatum Poir.	Dallis grass

DIVISION Family Species {Synonym}	**Common Names**
Paspalum floridanum Michx.	Florida paspalum, big paspalum
Paspalum pubiflorum Rupr. var. *pubiflorum*	hairy-seed paspalum, hairy-flower paspalum
Paspalum setaceum Michx.	thin paspalum
Paspalum urvillei Steud.	Vasey grass, Urville's paspalum
Phalaris canariensis L.	Canary grass
Phalaris caroliniana Walter	Carolina Canary grass, wild Canary grass
Poa annua L.	annual bluegrass, dwarf meadow grass
Poa arachnifera Torr.	Texas blue grass
Polypogon monspeliensis (L.) Desf.	rabbit's foot, annual beard grass
Polypogon viridis (Gouan) Breistr. {*Agrostis semiverticillata* (Forssk.) C.Chr.}	water bent grass
Schedonnardus paniculatus (Nutt.) Trel.	tumble grass, Texas crab grass
Schizachyrium scoparium (Michx.) Nash	little bluestem
Setaria parviflora (Poir.) Kerguelen {*Setaria geniculata* (Lam.) P. Beauv.}	knot-root bristle grass, perennial bristle grass
Setaria pumila (Poir.) Roem. & Schult. {*Setaria glauca* (L.) P. Beauv.}	yellow bristle grass
Setaria ramiseta (Scribn.) Pilg. {*Panicum ramisetum* Scribn.}	bristle grass
Setaria reverchonii (Vasey) Pilg. {*Panicum reverchonii* Vasey}	Reverchon's bristle grass
Setaria scheelei (Steud.) Hitchc.	southwestern bristle grass, Scheele's bristle grass
Setaria viridis (L.) P. Beauv.	green bristle grass, green foxtail grass
Sorghastrum nutans (L.) Nash	yellow Indian grass, Indian reed
Sorghum halepense (L.) Pers.	Johnson grass
Sphenopholis obtusata (Michx.) Scribn.	prairie wedgescale
Sporobolus compositus (Poir.) Merr. var. *clandestinus* (Biehler) Wipff & S.D. Jones {*Sporobolus clandestinus* (Biehler) Hitchc.} {*Sporobolus asper* (Michx.) Kunth var. *clandestinus* (Biehler) Shinners}	purple-flower dropseed
Sporobolus compositus (Poir.) Merr. var. *compositus* {*Sporobolus asper* (Michx.) Kunth}	tall dropseed, long-leaf rush grass, rough rush grass
Sporobolus compositus (Poir.) Merr. var. *drummondii* (Trin.) Kartesz & Gandhi {*Sporobolus asper* (Michx.) Kunth var. *pilosus* (Vasey) Hitchc.}	meadow dropseed
Sporobolus cryptandrus (Torr.) A. Gray	sand dropseed, covered-spike dropseed
Sporobolus ozarkanus Fernald	Ozark dropseed
Tridens albescens (Vasey) Wooton & Standl.	white tridens, whitetop
Tridens flavus (L.) Hitchc.	purpletop, redtop
Tridens muticus (Torr.) Nash var. *elongatus* (Buckley) Shinners	rough tridens
Tridens muticus (Torr.) Nash var. *muticus*	slim tridens
Tripsacum dactyloides (L.) L.	eastern gamma grass
Trisetum interruptum Buckley	prairie trisetum
Triticum aestivum L.	wheat, bread wheat

DIVISION Family Species {Synonym}	Common Names
Urochloa fasciculata (Sw.) R.D. Webster {*Brachiaria fasciculata* (Sw.) Parodi} {*Panicum fasciculatum* Sw.}	hurrah grass, browntop, brown-top signal grass
Vulpia octoflora (Walter) Rydb. var. *glauca* (Nutt.) Fernald	sixweeks grass
Vulpia octoflora (Walter) Rydb. var. *octoflora*	common sixweeks grass

Smilacaceae	**Greenbrier Family**
Smilax bona-nox L.	saw greenbrier, catbrier, bullbrier, fringed greenbrier
Smilax rotundifolia L.	common greenbrier, bullbrier, horsebrier
Smilax tamnoides L. {*Smilax hispida* Muhl. ex Torr.}	bristle greenbrier, Chinaroot, hellfetter, devil greenbrier, hagbrier

Typhaceae	**Cat-tail Family**
Typha domingensis Pers.	narrow-leaf cat-tail

APPENDIX I

Cave Species at Fort Hood

Cave Associated Species of Fort Hood

Species	Common Name	Range	Listing Status
Stygobromus bifurcatus	Bifurcated cave amphipod	Central Texas	Not listed
Stygobromus russelli	amphipod	Central Texas	Not listed
Caecidotea reddelli	isopod	Travis to Palo Pinto counties	Not listed
Cicurina (Cicurella) coryelli	spider	Fort Hood endemic	Not listed
Cicurina sp.	spider	Fort Hood endemic	Needs taxonomic work
Texella sp.	harvestman	Fort Hood endemic	Not listed
Cambala speobia	millipede	Central Texas	Not listed
Speodesmus sp.	millipede	Fort Hood endemic	Not listed
Siphonophora sp.	millipede	Edwards Plateau	Needs taxonomic work
Rhadine sp.	ground beetle	Fort Hood endemic	Not listed
Batrisodes sp.	mold beetle	Fort Hood endemic	Not listed
Batrisodes sp.	mold beetle	Fort Hood endemic	Not listed
Trimioarcus sp.	Beetle	Fort Hood endemic	Not listed
Folsomia sp.	springtail	Fort Hood endemic	Not listed
Hypogastrura (Cerato-physella) sp.	springtail	Fort Hood endemic	Not listed
Sminthurus sp.	springtail	Fort Hood endemic	Not listed
Ceuthophilus sp.	cave cricket	Fort Hood endemic	Not listed
Plethodon sp.	salamander	Fort Hood endemic	Needs taxonomic work

Source: ESMP 2001

APPENDIX J

Biological Opinion

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
WinSystems Center Building
711 Stadium Drive, Suite 252
Arlington, Texas 76011

2-12-04-F-478

March 16, 2005

Mr. Roderick A. Chisholm
Director of Public Works
Department of the Army
Headquarters, U.S. Army Garrison
Building 1001, Room W321
Fort Hood, Texas 76544-5000

Dear Mr. Chisholm:

This document transmits the U.S. Fish and Wildlife Service's (Service) biological opinion based on our review of the U.S. Department of Army's (Army) ongoing activities and proposed revision of the Endangered Species Management Plan (ESMP) at Fort Hood Military Installation in Bell and Coryell Counties, Texas, and its effects on the federally listed black-capped vireo (*Vireo atricapilla*) (BCVI) and golden-cheeked warbler (*Dendroica chrysoparia*) (GCWA). The Army's letter requesting consultation, dated September 1, 2004, was received at our office on September 7, 2004. Following our request for additional information, the consultation was initiated on October 25, 2004.

As you are aware, formal section 7 consultation between the Service and the Army concerning Fort Hood originally began in 1992. At that time, the Service's Austin Field Office had responsibility for addressing endangered species issues at Fort Hood. The original biological opinion, dated September 23, 1993, was amended three times to accommodate the changing needs of the Army and incorporate new information regarding the conservation needs of the listed species occurring at Fort Hood. Due in part to recent resource limitations the Service has encountered and continues to experience, the responsibility for endangered species issues at Fort Hood was transferred to the Arlington Field Office in 2003.

In subsequent meetings with our office and Fort Hood staff, it became apparent that the Army wished to reassess the Fort's ESMP to better suit their mission, and therefore, we recommended the Army reinitiate formal consultation. The initiative was to increase flexibility in training at Fort Hood, and as such, it was mutually agreed that a new biological opinion would be optimal, rather than another amendment to the previous opinion. While the previous opinion and its amendments would always remain a part of the consultation history and the administrative record, the new biological opinion would incorporate all ongoing activities that currently occur at Fort Hood, any proposed changes to the ESMP, an updated environmental baseline, the most current status of the species, and a complete incidental take statement (in the event of a non-jeopardy opinion). The result would be a ‘stand alone’ document that could be easily referred to without reference to several other documents and/or amendments. To this end, my staff in close coordination with the Fort Hood staff, incorporated all elements necessary to complete this comprehensive biological opinion.

This biological opinion supersedes the previous opinion and its amendments. It has been prepared in accordance with section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 *et seq*.). This biological opinion is based on the Biological Assessment (BA) included with your letter initiating consultation, information provided by Fort Hood Environmental staff, and other sources of information. A complete administrative record of this consultation is on file at the Service’s Arlington, Texas, Field Office (ARLFO).

Consultation History

1992 to 2000: The Army, Headquarters III Corps and Fort Hood, originally initiated consultation on September 24, 1992, with the Service’s Austin, Texas, Field Office, which resulted in a non-jeopardy biological opinion issued on September 23, 1993 (Service Consultation #: 2-15-93-F-003). The opinion was subsequently amended twice in 1999, and a third time in 2000 to incorporate the draft 2000-2004 ESMP, impacts from the 1996 fires, additional brown-headed cowbird minimization measures, off-road vehicle recreation, and juniper management.

June 2003: Responsibility for endangered species issues concerning Fort Hood is transferred from the Service’s Austin Office to the ARLFO.

January 15, 2004: Initial meeting at Fort Hood to discuss changes to the ESMP with representatives from the ARLFO, Texas Parks and Wildlife Department, Texas Department of Agriculture, The Nature Conservancy, and the Leon River Restoration Project. The Army’s training requirements and need for flexibility with regard to listed species encroachment, as well as plans for an off-site conservation plan were discussed. A working group was formed with representatives from each group (hereafter, ESMP Working Group) to work on the conservation plan and the revision of the Fort’s ESMP.

January 27, 2004: Meeting at Fort Hood with ESMP Working Group. Current off-site efforts through the Nature Conservancy and potential changes to the ESMP with regard to fires within the Live Fire Area were discussed. Omar Bocanegra explained the off-site plan’s relationship to section 7(a)(1) and 7(a)(2) of the Act, and encouraged the Army to draft a BA with respect to changes to the current activities and/or restrictions. The BA would then be used to re-initiate consultation to address the Army’s training needs and minimize impacts to listed species.

March 25, 2004:	Meeting at Fort Hood with ESMP Working Group. Proposals for off-site conservation were submitted by The Nature Conservancy, Environmental Defense, and the Leon River Restoration Project and discussed among the group. The Army discussed a draft outline of proposed changes to the ESMP.
July 7, 2004:	Meeting at Fort Hood with the Directorate of Public Works, Service, and Leon River Restoration Project representative. The ARLFO explained the consultation process to Colonel Randall Butler and staff. The Army expressed interest in expediting the consultation and indicated the draft BA was near completion.
July 20, 2004:	The ARLFO received the draft BA via electronic mail from the Army. Comments on the draft were sent to Fort Hood on August 3, 2004.
September 7, 2004:	The ARLFO received a final BA with letter requesting formal consultation with the Army on activities at Fort Hood. The ARLFO acknowledged receipt of the initiation request and asked for clarification on issues related to prescribed fire, recreational activities, and the grazing lease at Fort Hood in a letter dated October 4, 2004.
October 25, 2004:	The ARLFO received a letter from Colonel Bruzese providing supplemental information on the BA as requested. The ARLFO accepted the consultation beginning October 25, 2004, in a letter to Colonel Bruzese, dated October 28, 2004.

BIOLOGICAL OPINION

I. Description of Proposed Action

Fort Hood Military Reservation (hereafter, Fort Hood) provides resources and training facilities for active and reserve units in support of the Army's mission. Training activities conducted at Fort Hood include maneuver exercises for units up to brigade level, live weapons firing, and aviation training. In accordance with Army Regulation 200-3, Fort Hood has prepared and implemented an ESMP to promote the conservation of threatened and endangered species occurring on the installation while minimizing impacts on the training mission. The current ESMP was approved on October 10, 2000.

The proposed action consists of the ongoing military associated and other activities at Fort Hood and revision of the current installation ESMP. The Army and the Department of Defense (DoD) are currently undergoing major reviews of force structure and deployments under several transformation initiatives and the current round of Base Realignment and Closure activities. The ultimate outcome of these initiatives and consequences for Fort Hood, if any, are not known at this time. Also, if significant changes to the Fort Hood force structure or mission occur, these changes may not be implemented for several years. For these reasons, this project description reflects the current force and mission structure. The action area of the proposed and ongoing actions is limited to within the boundaries of Fort Hood.

A. Ongoing Activities

Ongoing activities at Fort Hood consist of military training activities, endangered species management, recreation programs, prescribed fire, juniper control program, cattle grazing, brown-headed cowbird (*Molothrus ater*) control program, management for other sensitive species, and population monitoring and research. No substantial changes are proposed for these ongoing activities; however, because the proposed changes to the ESMP directly or indirectly involve these activities, they are discussed under this project description for inclusion in the "Effects of the Action" section of the biological opinion.

Maneuver Training

Maneuver training exercises are conducted at all unit levels to ensure a combat ready fighting force. Training programs focus on units attaining and maintaining proficiency in collective tasks that support mission essential tasks. Units involved in the training process span all echelons from section to corps. III Corps' primary training focus at Fort Hood is the brigade level and below. Training exercises replicate combat conditions as closely as possible. Combat effects such as smoke, noise, and simulated nuclear, biological, and chemical conditions are integrated into every training event to condition units for operations in a difficult, stressful battlefield environment.

Units train for combat in a task-oriented manner. Trainers integrate combat, combat support, and combat service support elements to conduct multi-echelon, combined arms training. Combined arms training involves formations that include members of the entire fighting force. Commanders synchronize the activities of these forces within a battlefield framework that includes maneuver and operations within the deep, the close-in, and rear battle areas. Such exercises involve greater depth and rapidity of movement dimensions and, therefore, also incur greater demands for concurrent land use.

Maneuver training areas are located west, east, and southwest of the Live Fire Areas (Figure 1). Maneuver training areas constitute 53,300 ha (131,707 ac) or 61 percent of the entire installation. The West Range Maneuver Training Areas (Land Groups 4-6) provides excellent training opportunities for large armored and mechanized infantry forces. The training area averages seven to 10 km (4.3 to 6.2 mi) east to west and 30 km (18.6 mi) north to south. The area features a wide variety of terrain and vegetation characteristics that greatly enhance cross country, combined arms maneuver. Because of its large, contiguous size, this is the only maneuver area on Fort Hood capable of supporting brigade level operations.

The Northeast (Land Groups 1 and 2) and Southeast Range Maneuver Training Areas (Land Group 3) are divided by Belton Lake Reservoir. The northeast sector is heavily vegetated and cross-compartmentalized by terrain features, providing limited value as a mechanized maneuver area. The southeast sector provides more favorable terrain for mechanized units, but is only four to seven km (2.5 to 4.3 mi) north to south and 15 km (9.3 mi) from east to west. Because of limited area, the Northeast and Southeast Range Maneuver Training Areas are best suited for unit assembly and logistical areas, artillery firing points, and company and platoon level mounted and dismounted training. Additionally, these eastern training areas support engineer, combat support, and combat service support training, and provide locations for amphibious and river crossing operations.

The Southwest Maneuver Training Area is not used for maneuver training due to its small size and isolated location. The Southwest Maneuver Training Area (Land Group 7) is separated from the main cantonment area by U.S. Highway 190. This training area includes many restricted areas, including Robert Gray Army Airfield and the Ammunition Supply Point. The Southwest Maneuver Training Area is used primarily for small mechanized unit and dismounted infantry training and for logistical sites.

Live-fire Training

Fort Hood units train with the most modern and sophisticated weapon systems available. Fort Hood uses a Five-Year Range Modernization Program to manage upgrades and expansion of existing facilities and new construction projects to meet future training and evaluation requirements. Live-fire training facilities are located primarily in Live Fire Areas (LF) 80-93 and Permanent Dudded Area (PD94; Figure 1).

The Live Fire Areas and PD94 cover about 24,000 ha (59,305 ac) in the central portion of the installation, bounded on the east, west, and south by the East Range, West Range, and South Range roads respectively. Direct fire occurs inside these roads, and is directed towards the Artillery Impact Area and other target arrays. Indirect fire from artillery and Multiple Launch Rocket Systems is directed from numerous locations in surrounding maneuver areas. Much of the Live Fire Area provides a buffer zone for PD94 and has limited impacts from exploding ordnance. The Live Fire Areas provide training and evaluation facilities for all individual, crew-served, and major weapons systems, up to and including brigade live-fire. These Live Fire Areas are used by all active units assigned to III Corps and Fort Hood, as well as by attached units from the Army National Guard and the Army Reserve.

Modernized live-fire training facilities require continuous maintenance to maximize range design capability. Sensor devices must be serviced and cleared of concealing vegetation to ensure unimpaired operation. Target arrays must be visible at maximum engagement ranges. A program of range maintenance to routinely clear vegetation from target arrays and sensor devices is a critical component of range operation.

Aviation Training

Fort Hood has one of the largest military aviation commands in the United States. The aircraft, primarily rotary-wing, are some of the most modern and sophisticated in the world. Aviation units on Fort Hood train at all echelons from individual through battalion/squadron.

The training tasks accomplished in the training areas (Figure 1) include all tactical maneuvers in accordance with each aircraft's aircrew training manual and the unit's standard operating procedures. This includes nap-of-earth, contour, and low level flight. Fixed-wing aircraft of the Air Force and Air National Guard also conduct training missions in Fort Hood air space and use impact areas on the installation for weapons delivery practice.

Two major airfields are located on Fort Hood. The Hood Army Airfield is a 293 ha (724 ac) area located at the eastern end of the cantonment area. Hood Army Airfield is the primary airfield for rotary-wing air operations and has a 1,436 m (4,712 ft) runway. Robert Gray Army Airfield is an 867 ha (2,142 ac) area located at West Fort Hood with a 3,050 m (10,000 ft) runway. Several dirt landing strips are located on the installation for tactical air supply and support training.

Aircraft gunnery for AH-64 units is conducted on multi-purpose training ranges and PD94. However, the Dalton-Henson Range Complex (LF 80-82) is used most often for this training. Hellfire Missile Shots are conducted at Blackwell Multi-Use Range's Impact Area (PD94). Helicopter Door Gunnery is primarily conducted at Dalton Mountain Range or Crittenburger Range (LF 85-86). National Guard and Army Reserve units use the Dalton-Henson Range Complex for aviation training.

Operational Testing

Fort Hood's large maneuver and Live Fire Areas, coupled with III Corps modernized force, provide excellent conditions for operational testing of various weapons, equipment, and doctrine. The U.S. Army Operational Test Command (OTC) is a tenant activity located at West Fort Hood directly involved in training, doctrine, and combat development of the products that soldiers use on a daily basis and will use on the future battlefield. Most OTC tests employ "user testing," allowing front-line soldiers to try out new equipment or concepts. The tests generally encompass activities similar to those described in the sections on maneuver, live-fire, and aviation training.

Controlled/Prescribed Burning

Prescribed fire is a natural, economical, and effective management practice in some ecosystems. During the past 150 years in Texas, fire suppression practices have contributed substantially to the ecological imbalance of endangered species habitats. In many instances, properly applied fire can be one of the better tools to correct this problem. Fire presents a particular dilemma for the management of the BCVI and GCWA (collectively referred to as endangered species) on Fort Hood. Recovery times differ for GCWA and BCVI habitats after a stand-replacing fire. GCWA habitat that burns on Fort Hood generally regenerates first as BCVI habitat. Fire plays an important role in management of endangered species habitats on Fort Hood.

During extremely hot and dry conditions in late February 1996, approximately 2,728 ha (6,741 ac) of endangered species habitat were burned by wild fires on Fort Hood. This included about 2,313 ha (5,715 ac) of GCWA habitat and 415 ha (1,025 ac) of BCVI habitat. The GCWA habitat that burned substantially converted to BCVI habitat during the subsequent 2-5 years. New fire protection policies have been implemented on Fort Hood as a result of the 1996 fires and consultation with the Service.

Current prescribed fire policy emphasizes reduction of fuel loads in grasslands surrounding endangered species habitats on Fort Hood. Reduction of fuel loads mitigates the threat of wild fire damage in these habitats. Prescribed burns are managed through the Fort Hood Natural Resources Branch. Other objectives of the installation prescribed fire program are to reduce encroachment of Ashe juniper in all range sites, improve vegetation composition and improve wildlife habitats.

Juniper Cutting

After the listing of the GCWA in May 1990, juniper cutting on Fort Hood was suspended temporarily following informal consultation with the Service. Since Ashe juniper is an essential component of the habitat for this endangered species, it was determined that juniper cutting could have a negative impact.

During the period 1997-2000, under an agreement with the NRCS, Fort Hood resumed mechanical clearing of juniper in old-field and other areas not occupied by GCWA. These control efforts were focused on juniper removal on West Maneuver Training Areas and resulted in clearing juniper from approximately 14,500 ha (35,830 ac) of old fields and other non-endangered species habitat areas. All control efforts and contracts were coordinated through the Fort Hood Natural Resources Branch to avoid impact on endangered species habitats. Control efforts were not allowed within a 100-m (328-ft) buffer around endangered species habitats.

Grazing

Cattle grazing is permitted on Fort Hood under a lease agreement with the Central Texas Cattlemen's Association. The current lease extension expired September 15, 2004. This lease provides grazing opportunities on 80,000 ha (197,684 ac) of Fort Hood land. Negotiations are currently underway for a new lease. Under the new agreement, stocking rates are driven by the results of annual forage inventories. Grazing is deferred or stocking rate is reduced where forage production fails to meet thresholds that allow for training impacts and land management practices such as prescribed burning. The lease agreement requires the lessee not to impact endangered species, historical, archaeological, architectural, or other cultural features on the installation, and requires compliance with local, state, and federal water pollution regulations. A Supplemental Environmental Assessment (SEA) and 'Finding of No Significant Impact' for the Fort Hood grazing program was issued in January 2004. On February 22, 2005, an additional supporting document titled "Points of Agreement Regarding Methodology for Calculating Animal Units for Grazing at Fort Hood, Texas" was signed by representatives from the Army, Fort Hood, and the Texas Department of Agriculture. The methodologies outlined in this agreement will be used to determine the cattle stocking rate on the Fort based on available forage as discussed above, thus providing an adaptive management feature that will assist in minimizing impacts to listed species.

Cowbird Control Program

Fort Hood conducts extensive operations to reduce numbers of brown-headed cowbirds on the installation. The objective of the control program is to maintain the incidence of cowbird parasitism of BCVI nests below 10 percent annually, averaged over five-year periods. This program implements trapping and shooting activities that target feeding concentrations of cowbirds throughout the installation and cowbird individuals in endangered species nesting habitat. Summers and Norman (2004) provide details on the current implementation of the control program. In 2004, over 2,700 female brown-headed cowbirds were removed on Fort Hood during the GCWA/BCVI nesting season. Incidence of cowbird parasitism on BCVI nests in intensive study areas in 2004 was four percent.

Recreation

The post is open to public hunting and fishing. Access is regulated by the Range Control Division, Area Access office with the cooperation of Morale Support Activities and the Natural Resources Branch. Over 80,500 ha (198,920 ac) are managed for fish and wildlife, including 100 surface ha (247 surface ac) of lakes and ponds, 88 km (54.7 mi) of rivers and permanent streams, and 85 km (52.8 mi) of shoreline access to Belton Lake. In recent years, the installation has provided 90,000 fisherman-days and 45,000 hunter-days annually. White-tailed deer, wild turkey, migratory waterfowl, northern bobwhite, and mourning dove are hunted during restricted seasons. Deer and turkey hunts are carefully controlled. Small game hunting with shotgun is available in accordance with State of Texas seasons and bag limits.

Various low-impact outdoor recreation activities take place at the Belton Lake Outdoor Recreation Area located adjacent to TA 36. These include a swimming beach, camping, boating, trail bicycling, and cottage use. Boy Scout Camps are located in TA 36 and LTA 203. Hiking and nature observation activities are also allowed on many parts of the installation and are coordinated through Range Control Division. Mountain bike riding is restricted to a designated trail system at Belton Lake Outdoor Recreation Area. No off-road recreational vehicle use is permitted anywhere on the installation.

Management of other Sensitive Species

Fort Hood maintains an active program to monitor, manage, and protect sensitive natural resources and populations occurring on the installation. These include transient occurrence of endangered bald eagles and whooping cranes, a rare plant *Croton alabamensis*, several species of endemic karst invertebrates, and recently discovered new species of salamander, *Plethodon* sp.

The priority for management and protection of other sensitive species on Fort Hood is to minimize factors that could lead to future listing actions for these species. *Croton alabamensis* populations are visited annually to assess population status and monitor potential threats. At this time these locations are not disturbed by military training activities.

Fort Hood has an extensive network of karst features. In the 1990s extensive faunal surveys identified several endemic karst-associated invertebrates. Fort Hood implemented protective measures such as gating of caves to minimize human impacts on these populations. Surveys and mapping of caves are ongoing. Research has been conducted on populations status and effect of fire ant depredation on these systems. Fort Hood is currently developing a formal karst management plan.

Population Monitoring and Research Programs

Population monitoring programs on Fort Hood are established on the basis of adaptive management principles. Monitoring programs have been conducted on Fort Hood for both GCWA and BCVI since these species were listed. These programs have evolved over the years in response to new data requirements and management initiatives. Overall objective of the monitoring program is to determine population trends, demographic parameters, and effectiveness of management initiatives. Monitoring activities include intensive population and demographic data collection on selected intensive study areas, base-wide point counts and other targeted data collection activities. Details of the current monitoring program are found in The Nature Conservancy of Texas's 2004 Annual Report. Monitoring activities are assessed annually and adjusted as necessary to provide the best evaluation of population status and management practices.

Fort Hood also supports and hosts a variety of research efforts on endangered species populations on the installation. Fort Hood, the Army, and DoD support significant research programs to evaluate factors affecting endangered species populations on the installation including human disturbance, predator effects, noise impacts and habitat suitability. Many of these research efforts are currently in progress and results will be incorporated in future management approaches and policies.

Current information indicates that feral hogs have been increasing in abundance at Fort Hood and may influence the composition, succession, and quality of endangered species habitat. The extent of the effects feral hogs may have on endangered species habitat is unknown, but anecdotal evidence suggests that large populations of hogs could have both long and short term adverse impacts on endangered species. To address this problem, Fort Hood has recently begun controlling feral hogs through trapping and aerial shooting.

As a part of the endangered species population monitoring program, Fort Hood employs the use of helicopter over-flights to ensure compliance with training guidelines, observe the effects of training activity in endangered species habitat, control feral hogs, and monitor the presence and spread of oak wilt. Fort Hood's use of helicopter surveillance is an effective means of monitoring the available habitat, as well as providing aerial support for fighting fires that threaten habitat.

Fort Hood reports the status and results of these monitoring and research programs annually to the Service. Results are also presented at national symposia and through publication in peer-reviewed publications.

B. ESMP Revision

Changes to the ESMP are proposed to better suit the Army's mission and incorporate the most current information regarding the status and distribution of the BCVI and GCWA at Fort Hood and the effects of military and other activities on these species. The proposed changes are: (1) modification of current fire management and protection policy within Live Fire Areas, (2) reduction of habitat area designated as "core" for BCVI and GCWA subject to Fort Hood

Endangered Species Training Guidelines, and (3) projected habitat loss due to facility construction and maintenance activities. These actions are described in further detail below.

1. Fort Hood Fire Management and Protection Policies

Fort Hood currently has a fire danger rating system to alert trainers when pyrotechnic operation should be limited or halted based on current (daily) weather and estimated moisture content of vegetation and soil. Details of this rating system are found in OPLAN 8-93, "Operation Brush Fire" and Fort Hood Regulation 350-40. These fire ratings are:

> **Condition Green:** No restrictions on training. Troops may use pyrotechnics and incendiary munitions for training.
>
> **Condition Amber:** Caution must be taken in use of pyrotechnics. Aerial flares are not to be used outside the impact area. Other pyrotechnics are to be used only in roadways, tank trails, in areas clear of vegetation, or in containers.
>
> **Condition Red:** No pyrotechnics or incendiary munitions authorized for training purposes.
>
> **Condition Red with Waiver:** Once a risk assessment is conducted by Range Control and the recommendation for training with waiver is approved by the Director, Range Control, specific restrictions are imposed on training units.

Currently, under all fire condition ratings, fires are reported to Range Control by military units or installation personnel. If the fires are within range fans where live-fire training is being conducted, units will cease firing until a fire risk assessment is conducted or control measures are implemented. Range Control will determine the location of the fire and risk to facilities, personnel, or sensitive resources such as endangered species habitats. If Range Control determines there is no risk to facilities or habitats, the fire will be allowed to burn. Typical examples are fires occurring in the permanently-dudded impact area (PD94; Figure 1) where fires are extremely frequent and fuel loads are low. If a fire may risk endangered species habitat, Range Control will contact the installation Natural Resources Branch for an assessment of the risk based on proximity to high hazard areas, fuel load, topography and other parameters. If the fire risk to habitats is obviously high, Range Control may immediately implement fire control actions concurrent with notification of the Natural Resources Branch.

Under current procedures, fire control will be implemented under all fire condition ratings if a determination is made that endangered species habitat is at risk from a fire. Within the Live Fire Areas, the first response is usually by a contracted helicopter on standby for fire control. Under condition Red this helicopter is on 30-minute standby during 1100-1800 and two-hour standby during the rest of the day/night period. Other installation fire fighting assets are available for fire control as needed.

The proposed action would reduce requirements to conduct intensive fire suppression in Live Fire Areas during conditions Green and Amber. Fort Hood would establish a "let burn" policy for range fires that occur during periods when Fire Danger Rating is Green or Amber. Under Green and Amber ratings, fires would be allowed to burn in all habitat areas within the Live Fire Area unless there is obvious threat to personnel or facilities or until such time as changing environmental conditions warrant implementing increased fire control procedures.

In order to minimize potential impacts to endangered species habitat resulting from the proposed revisions to the Fort Hood Fire Management and Protection Policies, Fort Hood proposes the following measures:

- Fort Hood will monitor effects of all fires on endangered species habitat occurring on the installation. Fort Hood will maintain records on the date and area of endangered species habitat affected, and report these data annually to the Service. Fort Hood will allow safe and sufficient access to Live Fire Areas by Natural Resource Branch personnel and contracted biologists to monitor BCVI and GCWA productivity, predation, and population trends in these areas.

- Fort Hood will emphasize use of preventative prescribed fire to maintain blacklines near habitat areas annually. Fort Hood will employ firebreaks in association with endangered species habitats to reduce fire risk.

- Fort Hood will continue to use aerial support (helicopter) for fighting fires that pose a threat to important GCWA habitat areas.

Additionally, Fort Hood would implement habitat management prescriptions to maintain installation population goals for both BCVI and GCWA. The Fort would maintain suitable habitat to support 1,000 adult BCVI males and 2,000 adult GCWA males at maximum densities. GCWA habitat that burns on Fort Hood typically regenerates in the short-term as BCVI habitat. BCVI habitat on Fort Hood that is not periodically disturbed over time will become unsuitable for BCVI occupancy and may ultimately regenerate to GCWA habitat. The temporal and spatial pattern of fires and other disturbance creates a dynamic relationship between the availability of BCVI versus GCWA habitat.

This relationship between disturbance regimes and habitat suitability presents a challenge to installation natural resource managers to determine when and where habitat management prescriptions should be implemented to support the installation's overall endangered species population goals. Under the proposed action, Fort Hood would determine criteria and identify areas suitable for maintenance as BCVI habitat. Management prescriptions to maintain adequate areas of suitable BCVI habitat would rely first on passive management activities such as habitat creation and maintenance through the "let-burn" policy and mechanical disturbance from training activities. Secondarily, active management practices such as prescribed burns and mechanical clearing would be implemented as necessary to maintain installation population goals for BCVIs (see Ongoing Activities section).

2. Reduce Area Designated as 'Core' Habitat

Currently, 4,184 ha (10,339 ac) of BCVI habitat and 14,879 ha (36,767 ac) of GCWA habitat are designated as "core" habitat. Under this designation, training activity in habitats designated as core is subject to conditions of the Fort Hood Endangered Species Training Guidelines (Appendix A). These guidelines prohibit fixed activities greater than two hours duration in designated core habitats during the period 1 March through 31 August. Vehicle traffic is restricted to existing roads and trails in core habitats.

Under the proposed action, core habitat designation would be removed from all 4,184 ha (10,339 ac) of BCVI habitat, and core habitat designation for GCWA would be reduced to 3,861 ha (9,541 ac). For GCWA, core habitat designation would be implemented in habitats occurring in the East Ranges (land groups 2 and 3) as shown in Figure 2. Core habitats under this proposed action would constitute all GCWA habitats east of a water pipeline and north of Belton Lake, and habitats north of North Nolan Road and south of Belton Lake. The latter core habitat area includes the Belton Lake Outdoor Recreation Area and a long-term GCWA intensive monitoring study plot. Additionally, the time period for implementing Level 2 restrictions (Appendix A) would be reduced to 1 March through 30 June.

In accordance with principles of adaptive management, Fort Hood would implement or restructure monitoring programs to assess long-term effects, if any, of this action on endangered species populations and habitats on the installation. Designation of habitat as "core" or "non-core" is not a good indicator of the duration, frequency or intensity of training activity at any particular location under these designations. Because any level of transient activity is still allowed in core habitats, locations within these areas may still be subject to a high level of training activity. Conversely, depending on the training footprint, habitats designated as non-core may be subject to very little training activity at any particular location. For these reasons, monitoring programs to determine the relationship between training activity and long-term population and habitat trends would require some measure or index of training activity in association with study populations. Currently, an analysis is being conducted to assess historical differences in endangered species populations between currently designated core and non-core habitats. These analyses will be provided to Fort Hood prior to the 2005 breeding season for consideration in implementing programs to monitor long-term effects of training activity on endangered species populations and habitats.

Other DoD and Army research programs that directly address effects of military training activities on endangered species populations are currently ongoing or programmed for implementation. Although Fort Hood has no control or funding authorization for these research programs, the installation does provide technical review, site access and logistical support for these activities. Under this proposal, Fort Hood would continue to support execution of these research activities and would ensure that results are provided to the Service for review.

Off-site conservation and protection of endangered species habitats also provides an opportunity to offset potential effects of mission activities on Fort Hood. In FY04, Fort Hood provided funds in support of voluntary short-term habitat management through the Leon River Restoration Project, and funding to support permanent conservation easements and long-term Safe Harbor agreements through The Nature Conservancy and Environmental Defense. Fort Hood will continue to collaborate with other governmental and non-governmental agencies to identify off-site opportunities for habitat conservation and protection, particularly those covenants that will contribute toward species recovery goals as defined under the Act. Fort Hood will provide logistical and financial support for these activities contingent upon availability of funds.

3. Construction and Range Improvements.

Currently, construction and range improvement projects on Fort Hood that potentially eliminate endangered species habitat require individual consultations with the Service. Under the proposed action a programmatic incidental take would be established to cover anticipated take of habitat over a five-year period due to military construction and range improvement activities.

Master planning documents for major construction over the next five years anticipate a number of multi-purpose range upgrades, additional targetry, urban assault training facilities, and habitat alterations for tactical training land improvements such as tank trail construction and brush clearing for visibility. Table 1 shows examples of the types of projects anticipated under the current five-year master planning cycle. Current estimates are that endangered species habitat loss due to these activities during the next five-year master planning cycle would not exceed 325 ha (803 ac). Projected estimates are that approximately 2/3 (217 ha [536 ac]) of this total area would be GCWA habitat with the remaining habitat loss (108 ha [267 ac]) comprised of BCVI habitat.

Table 1. Examples of anticipated construction and range improvement projects during the next five-year planning cycle at Fort Hood, Texas. Refer to Figure 1 for action area locations.

Project Title	Proposed Action Areas
Killeen-Fort Hood Joint Military/civilian Use Airport expansion	West Fort Hood (WFH)
Browns Creek Digital Multipurpose Range Complex	LF 83
Lone Star Range Upgrades	LF 82
Brookhaven Scout Qualification Range	LF 88
Dalton/Henson Mountain Aviation Qualification Range	LF 80, 81, 82
Sugarloaf Digital Range Complex	LF 88, 89
Blackwell/Pilot Knob Digital Multipurpose Range	LF 90
Military Operations Urban Terrain/combined arms Combat Training Facility	LF 92, 93
Construction/Replacement of Primary and Secondary Tank Trails	Training Areas (TA)

Most of the anticipated construction and range improvement projects such as those shown in Table 1 are located within or immediately adjacent to Live Fire Areas (Figure 1). The range complex projects are examples of these. Examples of projects outside the Live Fire Areas include the Killeen-Fort Hood airport expansion and construction of tank trails. It is not anticipated that the entire project area for any of these projects would be completely within endangered species habitats, but it is anticipated that some level of habitat loss may be associated with these project actions.

The anticipated programmatic take under this proposal is based on historical requirements for similar projects, the likely footprints of projects in more advanced planning stages, and the level of anticipated construction activity. The actual take may not reach levels established under this programmatic proposal. All projects are subject to environmental review early in the planning stage to minimize impacts on sensitive natural and cultural resources. This planning requirement may result in take below the maximum anticipated levels. Likewise, unforeseen mission requirements may require proposed projects that could exceed take anticipated under this programmatic proposal. In this case, Fort Hood would need to enter into consultation with the Service for any projects that would exceed programmatic take anticipated under this proposal.

Improved and new tank trail construction may allow increased access to endangered species habitats (see Effects of the Action section). In Fort Hood's review and revision of monitoring programs, consideration would be given to determining changes in vehicle access and use of endangered species habitats.

II. Status of the Species

The current list of federally threatened, endangered, and candidate species that are known to occur, or have been documented in Bell and Coryell Counties is presented in Table 2. Candidate species are not afforded federal protection under the Endangered Species Act; however, the Service recommends that potential impacts to these species be considered during project planning.

Table 2. Federally listed species known to occur in Bell and Coryell Counties, Texas.

Common Name	Scientific Name	Status	County
black-capped vireo	*Vireo atricapilla*	Endangered	Bell, Coryell
golden-cheeked warbler	*Dendroica chrysoparia*	Endangered	Bell, Coryell
whooping crane	*Grus americana*	Endangered	Bell, Coryell
bald eagle	*Haliaeetus leucocephalus*	Threatened	Bell
Salado salamander	*Eurycea chisholmensis*	Candidate	Bell
smalleye shiner	*Notropis buccula*	Candidate	Bell

Currently, there are no known populations of the Salado salamander or smalleye shiner on Fort Hood. Additionally, habitat for these species does not occur within the action area.

Whooping cranes and bald eagles are transient on Fort Hood with documented occurrences along the shoreline and flood plain of Belton Lake. Fort Hood management policy for bald eagles is to minimize disturbance from low-level helicopter flights and other aviation assets. When bald eagles are observed in autumn the Fort Hood air-space coordinator is notified and a no-fly zone is implemented. This zone is located near Belton Lake in Land Group 2 and LTA 115. Flight restrictions are lifted when no bald eagles have been observed for a period of two weeks.

Observations of whooping cranes are uncommon on Fort Hood. In the event that this species is observed on the installation, the installation Director of Operations, Range Control Division, will be notified and training activities will be suspended in proximity to whooping cranes until they have departed installation lands.

Under the proposed action the current protection and reporting policies for these species would remain in affect. For these reasons, it is anticipated that the proposed action is not likely to affect the bald eagle or whooping crane, and therefore, these species are not considered further in this biological opinion.

Two federally listed endangered species that do occur in the action area and that may be affected by the proposed action are the BCVI and GCWA. The BCVI was listed by the Service in 1987 (52 FR 37420-37423). The Service emergency listed the GCWA on May 4, 1990 (55 FR 18844) and published a final rule on December 27, 1990 (55 FR 53153-53160). Critical habitat has not been designated for either of these species. The recovery plans for the BCVI and for the GCWA were finalized on September 30, 1991, and September 30, 1992, respectively.

Black-capped Vireo - The BCVI is an 11.4 centimeter (4.5 inch) long, insect-eating songbird. Mature males are olive green above and white below with faint greenish-yellow flanks. The crown and upper half of the head is black with a partial white eye-ring. The iris is brownish-red and the bill black. The plumage of the female is duller than the male. Females have a dark slate gray head (USFWS 1991).

BCVIs arrive in Texas from mid-March to mid-April, while BCVIs in Oklahoma arrive approximately 10 days later. They nest from Oklahoma south through central Texas to the Edwards Plateau, then south and west to central Coahuila, Mexico. A pair will most often be monogamous for the breeding season, selecting a nest site together, while the female completes nest construction in two to three days. BCVIs suspend their nests in the forks of shrubs in dense underbrush, from 0.3 to 0.9 meters (1 to 6 feet) above the ground; most nests are found around one meter (3.3 feet) above ground. Three to four eggs are usually laid in the first nesting attempt, but later clutches may only contain two to three eggs. The first egg is usually laid one day after nest completion, with one egg being laid each subsequent day. Incubation takes 14 to 17 days, and is shared by both the male and female. BCVI chicks are fed by both adults as well, and leave the nest 10 to 12 days after hatching (Campbell 1995).

Although BCVI habitat throughout Texas is quite variable with respect to plant species, soils, and rainfall, all habitat types have a similar overall appearance. BCVIs typically inhabit shrublands and open woodlands with a distinctive patchy structure. The shrub vegetation generally extends from the ground to about 1.8 meters (6 feet) above ground and covers about 30% to 60% of the total area. Open grassland separates the clumps of shrubs. In the eastern portion of the BCVI's range, the shrub layer is often combined with an open, sparse to moderate tree canopy. In the Edwards Plateau and Cross Timbers regions, common plants in BCVI habitat include Texas red oak (*Quercus buckleyi*), Lacey oak (*Quercus glaucoides*), white shin oak (*Quercus sinuata* var. *breviloba*), Durand oak (*Quercus durandii*), Plateau live oak (*Quercus fusiformis*), Texas mountain laurel (*Sophora secundiflora*), evergreen sumac (*Rhus virens*), skunkbush sumac (*Rhus trilobata*), flameleaf sumac (*Rhus lanceolata*), Texas redbud (*Cercis canadensis* var. *texensis*), Texas persimmon (*Diospyros texana*), honey mesquite (*Prosopis glandulosa*), and agarita (*Berberis trifoliolata*). Densities of Ashe junipers (*Juniperus ashei*) are usually low. In the western Edwards Plateau and Trans-Pecos regions, BCVIs are often found in canyon bottoms and slopes containing plants such as sandpaper oak (*Quercus pungens*), white shin oak, Texas kidneywood (*Eysenhardtia texana*), Mexican walnut (*Juglans microcarpa*), fragrant ash (*Fraxinus cuspidata*), mountain laurel, and guajillo (*Acacia berlandieri*). BCVI habitat is related to disturbance, and thought to have been created by natural disturbances (e.g., fires) in areas with rocky substrates and shallow soils, which generates successional habitat (Koloszar et al. 2000).

Threats to the BCVI include habitat loss and degradation due to development, habitat succession, poor grazing practices, brown-headed cowbird (*Molothrus ater*) parasitism, and low reproductive success. Throughout the Hill Country, much of the BCVI's habitat has been destroyed or degraded by residential and commercial development, grazing practices, and fire suppression.

BCVIs may live for more than five years, and usually return year after year to the same territory. The birds begin to migrate to wintering grounds on Mexico’s western coast in July, and are gone from Texas by mid-September (Campbell 1995).

Golden-cheeked Warbler - The GCWA is a small, insectivorous songbird, 11.4 to 12.7 centimeters (4.5 to 5 inches) long, with a wingspan of about 20 centimeters (7.9 inches). The male has a black back, throat, and cap, and yellow cheeks with a black stripe through the eye. Females are similar, but less colorful. The lower breast and belly of both sexes are white with black streaks on the flanks (USFWS 1992).

The GCWA nests in the juniper-oak woodlands of the Texas Hill Country and winters in the pine-oak woodlands of southern Mexico, Guatemala, Honduras, and Nicaragua. Its entire nesting range is confined to 33 counties in central Texas. Typical nesting habitat is found in tall, dense, mature stands of Ashe juniper mixed with deciduous trees such as Texas red oak, Lacey oak, white shin oak, live oak, post oak (*Quercus stellata*), Texas ash (*Fraxinus texensis*), cedar elm (*Ulmus crassifolia*), hackberry (*Celtis occidentalis*), bigtooth maple (*Acer grandidentatum*), sycamore (*Platanus occidentalis*), Arizona walnut (*Juglans major*), escarpment cherry (*Prunus serotina*), and pecan (*Carya illinoinensis*). This type of woodland is often found in relatively moist areas such as steep-sided canyons and slopes. GCWAs are also occasionally found in drier, upland juniper-oak, i.e., live oak, post oak, blackjack oak (*Quercus marilandica*) woodlands over flat topography. Although the composition of woody vegetation may vary from place to place, Ashe juniper, which is necessary for nest construction, is always present.

The males arrive in central Texas in early March and begin to establish breeding territories, which they defend against other males by singing from visible perches within their territories. The females arrive a few days later but are more difficult to detect in the dense woodland habitat.

Usually three or four eggs are laid. The average nest height is five meters (16.4 feet) above ground. Eggs are generally incubated in April and, unless there is a second nesting attempt, nestlings fledge in May to early June. Migration south to the wintering grounds occurs in July and early August.

The primary threats to the GCWA are habitat loss and urban encroachment. Other factors include the loss of deciduous oaks (used for foraging) to oak wilt, nest parasitism by brown-headed cowbirds, and predation and competition by blue jays (*Cyanocitta cristata*) and other urban-tolerant birds (USFWS 1992).

III. Environmental Baseline

A. Description of the action area

Fort Hood dates to 1942 when the Army established Camp Hood to prepare soldiers for tank destroyer combat during World War II. Renamed Fort Hood, it became a permanent installation in 1950. Various armored divisions have been assigned to Fort Hood since 1946.

Fort Hood is the only installation in the United States currently assigned two divisions. The installation provides the infrastructure and training lands for the 1st Cavalry Division and the 4th Infantry Division (Mech), III Corps Headquarters and its combat aviation assets, combat support, and combat service support units. With increased emphasis on force structure changes and Base Realignment and Closure initiatives, Fort Hood will likely remain the largest active U.S. installation in terms of assigned personnel. Total assigned personnel authorization is approximately 50,000 soldiers.

Fort Hood encompasses approximately 87,890 ha (217,180 ac) in Bell and Coryell Counties in central Texas. It lies at the northern extent of the Edwards Plateau and entirely within the Lampasas Cut Plains physiographic region and Grand Prairies Land Resource Zone. The Lampasas Cut Plains is typically vegetated with oaks such as Texas red oak, live oak, and white shin oak on the rocky Edwards limestone summits of small divides (Diggs et al. 1999). On large divides, areas of deeper soil typically support the westward extension of the Washita Prairie (Hayward et al. 1992). On the chalky thin soiled slopes derived from the underlying Comanche Peak limestone, white shin oak, sumac species, and Ashe juniper may be seen; these dry rocky areas have a distinctly desert-like microclimate (Hayward et al. 1992) and thus support plants with xerophytic adaptations. Below these slopes, on benches in valleys or on the summits of uplands lacking caprock, extensive areas of prairie can be found on the clay soils derived from the Walnut formation where it is exposed (Diggs et al. 1999). The basal Trinity Group sands (Paluxy, Antlers, Twin Mountains-Travis Peak) underlying the Walnut formation developed typical Cross Timbers vegetation such as post oak and blackjack oak (Hill 1901).

The topographic diversity and deeply cut streams found in various parts of the Lampasas Cut Plain provide important microhabitat variation. In particular, the diverse microhabitats allow the northward extension of many species otherwise found primarily on the Edwards Plateau. Some plants that were traditionally considered Edwards Plateau endemics can be found in the

Lampasas Cut Plain. These include big-tooth maple, plateau gerardia (*Agalinis edwardsiana*), wild mercury (*Argythamnia aphoroides*), Wright's milk-vetch (*Astragalus wrightii*), plateau false nightshade (*Chamaesaracha edwardsiana*), scarlet clematis (*Clematis texensis*), Lindheimer's silktassel (*Garrya ovata* var. *lindheimeri*), plateau milkvine (*Matelea edwardsensis*), Lindheimer's muhly (*Muhlenbergia lindheimeri*), devil's-shoestring (*Nolina lindheimeriana*), Heller's marbleseed (*Onosmodium helleri*), Lindheimer's rock daisy (*Perityle lindheimeri*), escarpment cherry, turnip-root scrufpea (*Pediomelum cyphocalyx*), plateau spiderwort (*Tradescantia edwardsiana*), Colorado Venus'-looking-glass (*Triodanis coloradoensis*), Lindheimer's crownbeard (*Verbesina lindheimeri*), and twisted-leaf yucca (*Yucca rupicola*).

Data obtained from the Army's Land Condition Trend Analysis (LCTA) Program at Fort Hood indicate that the installation is divided mainly into perennial grassland (65 percent) and woodland (31 percent) community types (Tazik et al. 1992), with relatively little shrubland. Most of the grasslands exhibit a dense or closed vegetative cover (83 percent). As a result of a history of grazing and military activity, the installation's grasslands are dominated by Texas wintergrass (*Stipa leucotricha*) (29 percent) and prairie dropseed (*Sporobolus heterolepis*) (18 percent), with little bluestem (*Schizachyrium scoparium*) grasslands comprising only nine percent of the grassland area (Tazik et al. 1993). Broadleaf woodlands comprise about 39 percent of LCTA woodland sites and typically are dominated by oaks. Coniferous and mixed woodlands comprise 61 percent and are dominated by Ashe juniper or a mixture of juniper and various oaks.

Elevation ranges from 180 m to 375 m (590 to 1,230 ft) above sea level with 90 percent of the area below 260 meters (853 ft). Higher elevations occur on the western portions of Fort Hood and the lowest at the Belton Lake shoreline adjoining the installation on the east. Surface water drains mostly in an easterly direction. Most slopes are in the two to five percent range. Lesser slopes occur along flood plains, while slopes in excess of 45 percent occur as bluffs along flood plains and as side slopes of mesa-hills.

B. Status of the species within the action area

Black-capped Vireo

Monitoring and research activities for BCVI on Fort Hood were initiated in 1987 and continue to the present. Research and conservation efforts include an inventory and monitoring program, remote camera studies of nest depredation and assessment of training activities in habitat, a habitat restoration program, and a cowbird control program. Currently, intensive study plots are established at four sites on the installation.

Based on an installation-wide survey conducted in 2002 and 2003, the current estimate of suitable BCVI habitat on Fort Hood is 6,967 ha (17,216 ac) (Cimprich 2003, Figure 2). This total habitat area does not include the 4.1 ha (10.0 ac) of habitat occurring on Fort Hood lands that are being transferred to Texas A&M University. Approximately 90 percent of suitable BCVI habitat is estimated to be occupied by BCVIs (Cimprich 2003).

Distribution of habitat and populations on Fort Hood is dependent on historical disturbance patterns that result in the preferred habitat structure. Currently, major concentrations of habitat and populations are found in the Live Fire Areas where fire is the predominant disturbance factor, in the west ranges where a combination of fire and mechanized military training has created habitat, and in Land Groups 1 and 2 where fire in 1996 and mechanical range clearing in the mid 1980s has created extensive habitat. BCVI habitat on Fort Hood is typically located on steep slopes and mesa tops and is embedded in a landscape matrix of GCWA habitat and open grassland/savannah.

During the 2002-2003 installation-wide survey, 1,847 adult BCVI males were observed (Cimprich 2003). In intensive study areas with known densities, these surveys detected approximately 25 percent of the known population. If this calibration is extrapolated to the entire installation, this would result in a population estimate of 7,388 territorial males; however, the precision of this estimate is unknown and therefore should be considered with caution (Cimprich 2003). An installation goal of habitat carrying capacity to support 1,000 adult BCVI males at maximum densities has been established based on population viability analyses (Hayden et al. 2001). The observed and estimated populations on Fort Hood exceed this goal by a factor of two to seven times.

Demographic data for 2003 (Cimprich 2003) indicated the daily probability of nest survival was lower in the egg-laying stage than during incubation or the nestling stage, and the probability of survival from the beginning of egg-laying to the end of the nestling period was 23 percent. No trend in nest survival over the past seven years was detected, although daily survival in the incubation period was lower in 2003 than in 2002. Despite relatively high nest predation and low nest success, 58 percent of territorial males succeeded in producing ≥ 1 fledgling. Successful nests produced a mean of 3.25 fledglings and territorial males produced a mean of 1.60 fledglings over the entire season.

Golden-cheeked Warbler

Monitoring and research activities for the GCWA on Fort Hood were initiated in 1991 and continue to the present. Research and conservation efforts include assessment of population trends, demographic and reproductive monitoring, habitat selection studies, habitat fragmentation and wildfire studies, and population viability analyses. Intensive study plots are currently established at three sites on the installation.

Currently, it is estimated that approximately 21,422 ha (52,935 ac) of suitable GCWA habitat occur on Fort Hood (Hayden et al. 2001) (Figure 2). This total habitat area does not include the 70 ha (173 ac) of habitat occurring on Fort Hood lands that are being transferred to Texas A&M University. GCWA occurrence has been documented in all training areas that have suitable habitat, including the Live Fire Area. An analysis of point count survey data show the abundance of GCWAs on Fort Hood has increased from 1992 to 2003 (Peak 2003). Using GCWA densities from intensively studied areas, the population on Fort Hood is estimated to range from 2,901 to 6,040 singing males. Observed density in 2003 on intensive study plots was 0.21 males/ha, which extrapolated to all available habitats would produce an estimate of 4,514 territorial males (Peak 2003).

Pairing success in 2003 was 82 percent and was similar to other years during 2000-2003. Daily survival probability of nests during 2000-2003 ranged from 0.94 to 0.97 and was not significantly different among years. Nest success (percent of males fledging at least one young) during the 2000-2003 period ranged from 23 to 40 percent.

The goal of Fort Hood for a minimum viable population is to maintain suitable habitat to support 2,000 males at maximum density (Hayden 2001). Current population estimates exceed this goal by a factor of two to six. Analyses by Peak (2003) indicated that productivity and nest success of Fort Hood GCWA populations are adequate to maintain stable population growth, and in some years may exceed requirements.

IV. <u>Effects of the Action</u>

The direct and indirect effects of the proposed action involve all activities related to the operation and maintenance of a military installation and other non-military related activities including research and management of federally listed species. The proposed action is described as Ongoing Activities and ESMP revisions, which overlap in scope and cannot be easily separated for an effects analysis without needless redundancy. This section categorizes the potential effects of the proposed action for convenience and references other discussions of effects where necessary to avoid repetition.

A. Ongoing Activities

Direct and indirect effects to the BCVI and GCWA as a result of military and other activities at Fort Hood are anticipated as these activities occur within and adjacent to endangered species habitat in the action area. These anticipated effects include habitat loss, disruption of breeding behavior such that productivity is affected, and loss of nests and/or young. Potential effects related to human disturbance on avian populations have been reviewed and reported in several studies (e.g., Wilcove 1988, Riffell et al. 1996, Gutzwiller and Hayden 1997, Gutzwiller et al. 1998). Habitat loss due to ongoing activities is largely a result of wildfire within the Live Fire Area. Wildfire may also impact endangered species habitat outside of the Live Fire Area, as in the 1996 fire that burned approximately 2,313 ha (5,715 ac) of GCWA habitat and 415 ha (1,025 ac) of BCVI habitat. The effects of Live Fire Training on endangered species are discussed further under "ESMP Revisions" in this section. Other effects of Ongoing Activities are discussed below.

Black-capped Vireo

Maneuver training activities are anticipated to affect the BCVI where its habitat is distributed in the west ranges and Land Groups 1 and 2. Military training would be infrequent in BCVI habitat that occurs on steep slopes due to limited access. However, BCVI habitat located on flat areas is accessible to vehicles and personnel and provides a degree of tactical cover that is desirable in training scenarios. BCVI nests are susceptible to direct destruction due to their proximity to the ground and shrub substrate. Since BCVIs use relatively ephemeral, patchily distributed habitats, they are likely adapted to a relatively high level of habitat fragmentation.

Off-road vehicle use and military bivouacs (e.g., tactical operations centers) have been observed in some BCVI habitats since access restrictions were lifted in some areas as a result of implementation of the installation ESMP in 2000. However, observed direct and indirect effects on BCVI in these habitats have been minimal in sites that are intensively monitored. In the last two years, five incidents were reported where military personnel were in close proximity to active nests and were requested to move. In one of these cases, military personnel had put sleeping cots to dry on top of a shrub with an active nest. These personnel were made aware of the nest presence and removed their equipment from the area. This nest remained active subsequent to this event. In another case, it is believed vehicle and personnel in the vicinity of an active nest led to its abandonment. In this case, the banded adult male associated with this nest was not observed again in the area. Another nest was lost in the building stage when a wheeled military vehicle apparently backed over the nest bush. The adult pair subsequently successfully re-nested in the same area. These two documented nest losses in the last two years are out of 402 monitored BCVI nests during this period. Habitat disturbance due to off-road vehicle activity in habitats in the form of crushed or damaged shrubs has been observed. This damage is typically localized with limited alteration of the overall habitat matrix.

Several factors of BCVI biology and habitat preference ameliorate potential effects of disturbance from military activity in habitats. Preliminary physiological and behavioral data collected by T. Hayden on Fort Hood suggests BCVIs may be relatively tolerant of human presence. In 2001 and 2002, physiological stress was assessed in white-eyed vireo (*Vireo griseus*) populations in core BCVI habitat and in unprotected habitat. White-eyed vireos are a closely related con-generic to BCVIs, have similar nesting characteristics, and are locally sympatric with BCVI territories. Measures of corticosterone, the indicator stress hormone in birds, was not significantly different between individuals sampled in protected versus unprotected habitats in 2001 and 2002, suggesting that this species is not chronically stressed in unprotected habitats above levels observed in protected habitats (Hayden, unpublished).

Training activity at any particular site is relatively infrequent and typically of short duration. Observed training patterns at Fort Hood are similar to those studied at Fort Stewart, Georgia, where a relative few sites received the majority of training activity and the majority of this activity was road/trail transit by wheeled vehicles (Hayden et al. 2002). It is expected that BCVIs at any specific locality would have infrequent exposure to military activity of limited duration. A limited number of sites on Fort Hood are known to have a higher probability of military activity relative to the installation as a whole.

Harassment of breeding BCVIs from disturbance due to training activity is most likely to occur from fixed activities within habitat. Fixed activities include establishment of artillery firing points, tactical operation centers, or other field support facilities. Tactical doctrine dictates that artillery units should limit their exposure at any one location. In most cases these units would perform their mission function at the site and depart the location within a few hours to generally no more than 48 hours. Tactical operation centers and field support facilities operate in conjunction with field training exercises that typically run for no more than a two week period. Duration of these field facilities at any one site is typically limited to a few days at most.

BCVIs have a high incidence of double and even triple brooding and repeated re-nest attempts after nest failure. Adult males have been documented to initiate as many as seven nesting attempts during a season at Fort Hood. Impacts to nests and disruption of breeding behavior may affect BCVI productivity depending on the timing of impacts within the breeding season. For example, females that may have been capable of double brooding may only successfully brood once if an impact to the first nesting attempt occurs at a point in the season so as to not allow for two subsequent broods. Alternatively, the loss of a nest or nesting attempt early in the season may not result in an overall loss of productivity due to the species ability to re-nest if necessary.

It should also be noted that extensive areas of habitat at Fort Hood are apparently maintained due to mechanical disturbance by training activity. Approximately 8.1 percent (567 ha [1,401 ac]) of BCVI habitat at Fort Hood is attributed to and maintained by mechanical disturbance from training activity. In the West Ranges, where currently there are no training restrictions, habitats maintained by mechanical disturbance comprise approximately 16.4 percent of BCVI habitat. Due to the earlier successional character of BCVI habitat at Fort Hood, regeneration after physical disturbance is quite rapid. In most cases, only excessive erosion would potentially preclude regeneration after disturbance. BCVI habitats on Fort Hood that are most likely to be disturbed are predominantly flat with limited erosion potential.

Golden-cheeked Warbler

Studies of non-military activities have documented potential effects of human-related activities on the GCWA. Several studies have documented adverse impacts on GCWAs due to urbanization attributed to increased habitat fragmentation, edge, and avian predators (e.g., Sexton 1991, Coldren 1998, Fink 1996, Arnold et al. 1996, Engels 1995). These studies indicate that GCWAs select against habitat edge and reproductive success is reduced in proximity to edges. Studies at Fort Hood in 1995-96 indicated that mating success was lower in more fragmented habitats on the installation (Maas 1998).

GCWA habitat may be directly impacted by off-road vehicle traffic through the destruction or damage of trees. These impacts are likely small in size (limited to individual trees) and localized for the following reasons. Off-road vehicle traffic is largely precluded in GCWA habitat either by topography (steep slopes) and/or density of the associated vegetation. Wheeled vehicles would be unable to traverse through most GCWA habitat. Tracked vehicle transit through habitat is uncommon due to potential damage to the vehicles. Also, transit through vegetation that leaves obvious tracks does not conform to tactical doctrine, which dictates that such activity would increase detection by opposing forces and is therefore inadvisable. No loss of habitat or direct damage to nests due to military activity has been observed in either designated Core or non-core GCWA habitats since monitoring was initiated in 1991.

Fixed activities associated with field training exercises are also uncommon in GCWA habitat due to topography and vegetation density. Examples of fixed activities include artillery firing points, tactical operations centers, communications centers and field medical units. Facilities associated with these activities include personnel, vehicles and trailers, tent facilities, and electrical generator use. The area occupied by these activities is typically < 10 ha (25 ac). GCWA habitat is not suitable for these field training facilities which require some degree of open space that is not characteristic of the species' habitat.

Controlled/Prescribed Burning

The prescribed burning program at Fort Hood would help reduce fuel loads in proximity to endangered species habitat. This will have the effect of reducing the potential for uncontrolled wildfire in endangered species habitats. Fire would also be used to remove encroaching juniper from BCVI habitat within military training areas. The overall long term effects of prescribed fire would be beneficial to the BCVI and GCWA. Adverse effects, if any, would occur as loss of habitat and likely be short term.

Juniper Cutting

Juniper cutting is currently not conducted in GCWA habitats and would not be conducted under the proposed action. Juniper cutting to control encroachment in old fields would not affect endangered species populations on Fort Hood. Selective removal of second-growth juniper from BCVI habitat with a tree shear is conducted primarily in the western maneuver area, where mechanical effects of military training, rather then fire, is the primary disturbance mechanism. This technique for habitat management, particularly when coupled with a cool season prescribed burn under mild conditions, is useful for habitat enhancement in areas where a stand replacement fire is not appropriate, and will continue to be used as a tool. This selective removal of juniper conducted outside of the breeding season is anticipated to have an overall beneficial effect to the BCVI. Short term effects to habitat would be insignificant.

Grazing

Currently, negotiations for a new cattle grazing lease at Fort Hood have not been finalized. The new lease agreement would be consistent with the grazing SEA and the "Points of Agreement Regarding Methodology for Calculating Animal Units for Grazing at Fort Hood, Texas" dated February 22, 2005 (grazing agreement).

Cattle may directly affect BCVI habitat by browsing on preferred nesting shrubs, but these effects are anticipated to be insignificant, and would only be considered where lack of management allowed overgrazing in BCVI habitat (USFWS 1991, Campbell 1995). The majority of potential effects related to grazing are indirect, involving the relationship of grazing activity and the presence of the brown-headed cowbird (Summers and Norman 2004). Studies at Fort Hood have demonstrated an association of brown-headed cowbird feeding sites with areas of cattle grazing (Koloszar and Horne 2000). Parasitism by brown-headed cowbirds has been shown to significantly reduce nest success and productivity of BCVIs on Fort Hood (Hayden et al. 2000). However, cowbird control efforts at Fort Hood have significantly reduced the effects of cowbird parasitism that might be associated with cattle grazing at Fort Hood (see Cowbird Control Program below).

Changes in the stocking rate would be based upon current forage inventories, the grazing SEA, and the grazing agreement, which provide adaptive management practices conducive to endangered species habitat management. The indirect effect of cowbird parasitism, while influenced by the grazing program, is greatly minimized through the cowbird control program. The objective of the cowbird control program is to maintain an annual parasitism rate for the BCVI below 10 percent (averaged over five-year periods) regardless of the cattle stocking rate. The grazing program is not expected to result in take of endangered species provided the allowed stocking rate is based upon current forage inventories and the cowbird control program maintains the parasitism goal.

Cowbird Control Program

The cowbird control program is likely the single most important factor in the observed increases in BCVI and GCWA populations at Fort Hood. Data from Fort Hood shows that without cowbird control, incidence of parasitism of BCVI nests was 90-100% (Tazik et al. 1992). The cowbird control program has reduced the incidence of cowbird parasitism installation-wide, averaging less than 10 percent annually (Hayden et al. 2000, Cimprich 2003). The incidence of cowbird parasitism has a strong negative correlation with BCVI reproductive success (Hayden et al. 2000). Although this relationship is less definitive from the available data for GCWAs, this species is a host to brown-headed cowbirds and likely benefits from reduced cowbird parasitism. The cowbird control program has a significant beneficial effect for both BCVIs and GCWAs at Fort Hood.

Recreation

The potential effects of recreation programs at Fort Hood to the BCVI and GCWA are expected to be insignificant. Fishing activities generally are not conducted in endangered species habitats. Effects of hunting generally would be limited to potential harassment where the hunting season overlaps the endangered species breeding season. Turkey and other bird hunting is often conducted in savannah or riparian habitats not typically occupied by endangered species. Deer hunting is conducted during the non-breeding season of endangered species populations and helps control the potential for over-browsing of endangered species habitat.

Mountain biking is restricted to the Belton Lake Outdoor Recreation Area (BLORA), which contains occupied habitat for the GCWA. Studies by A. Graber on Fort Hood and the Austin area in 2002 and 2003 indicated that GCWAs in habitat areas with recreational trail bike riding had lower reproductive success and larger home ranges (Graber, unpublished data). However, recent studies of GCWA populations at BLORA did not show mountain bike activity to have an adverse impact on the species (Pekins 2002).

Population Monitoring and Research Programs

Monitoring and research programs on Fort Hood are designed to support an adaptive management approach for endangered species populations at Fort Hood. These activities will be modified as necessary to determine response of endangered species populations to actions implemented under the proposed ESMP revision. These data will allow installation natural resource managers to proactively respond to any observed changes in habitats or populations.

B. ESMP Revision

1) Fort Hood Fire Management and Protection Policies

Under the proposed action, fires within the Live Fire Areas would be allowed to “let burn” under fire conditions Green and Amber. Historically, a “let-burn” fire management policy was in effect for the 50-years prior to listing the GCWA as endangered in 1990. During this period, ranges within the Live Fire Areas were subject to the full spectrum of weapons use that was essentially similar to present use including firing of direct and indirect artillery, incendiary devices, small arms, crew-served weapons, and aerial rocketry and munitions. With the exception of habitats burned during the 1996 wildfire, the current mosaic of BCVI and GCWA habitat reflects results of the pre-1990 fire regime. The pre-1990 fire regime resulted in conversion or maintenance of habitat to grassland or to shrub land habitats occupied by BCVIs. GCWA habitat within the Live Fire Areas typically persisted in areas within buffer zones between firing zones and were protected by topography or buffered by BCVI habitat with low fuel loads.

Installation surveys during the 1987-90 period indicated 50 percent of the known BCVI population on Fort Hood occurred within the Live Fire Areas. The lack of heavy mechanized training and limited personnel access within the Live Fire Areas provides essentially undisturbed habitats for GCWAs and BCVIs.

Available data for 1992 through 2003 (excluding the 1996 wildfires) indicates a loss of GCWA and BCVI habitat for all of Fort Hood under the current fire management policy (Table 3). During these years, 0.1 percent (0.2 ha [0.5 ac]) of all GCWA habitat burned occurred during the peak nest months April-June. Of the total BCVI habitat burned, 23 percent (28 ha [69 ac]) burned during the months April through June. The largest one-year loss of GCWA habitat was 65 ha (161 ac) in 1992. The largest one-year loss of BCVI habitat was 36 ha (89 ac) in 2003. Fires in the Live Fire Areas comprised > 80% of the fire totals shown in Table 3.

Table 3. Area (hectares) of golden-cheeked warbler (GCWA) and black-capped vireo (BCVI) habitat burned during 1992-03 (excluding 1996).

Species	Year										
	92	93	94	95	97	98	99	00	01	02	03	Avg.
GCWA	65	14	6	5	4	1	0	15	2	6	51	15
BCVI	9	11	12	14	26	0	0	4	0	4	36	11

Under the proposed action, fire frequency in endangered species habitats and area of habitat burned may increase over levels observed under normal conditions during the 1992-03 period. Most fires would be expected to occur within BCVI habitats in the Live Fire Areas, since these areas historically have been burned due to ordnance use and are typically the habitat type adjacent to target areas. Burning of these BCVI habitats would result in unsuitability for occupancy for a period of 1-5 years. It is expected that the overall habitat mosaic resulting from this policy would be similar to conditions resulting from the pre-1990 period when fires were allowed to burn.

Loss of GCWA habitat may also increase over 1992-2003 levels under the proposed action, but overall fire dynamics are expected to reflect pre-1990 conditions. Most current habitat within the Live Fire Area is located in buffer areas for range fans. GCWA habitat typically is not located within or adjacent to heavily impacted target areas, since these areas are subject to frequent fires. Fires that occur under the proposed let burn policy within GCWA habitat are expected to be relatively low intensity, since the habitat at Fort Hood typically does not carry fire well under conditions of Green and Amber. GCWA habitat that is burned at Fort Hood converts to BCVI habitat in 1-5 years depending on fire intensity and site characteristics. Virtually all GCWA habitat areas that were burned in the 1996 fires have been subsequently occupied by BCVI (Cimprich 2003). Burned GCWA habitat would be expected to become suitable for use by the species only after a minimum of 25-30 years with no subsequent disturbance.

Several factors associated with the proposed fire management policy would minimize potential effects to endangered species. Fort Hood would maintain restrictions on use of ordnance and incendiary devices as the fire danger rating increases (see Description of the Proposed Action). These restrictions reduce the likelihood of military-related fires as fire risk increases due to environmental conditions. Current fire management and suppression requirements would remain in effect under danger rating Red, which would reduce the possibility of uncontrolled wildfires in endangered species habitats. This includes the use of an on-call helicopter as a first-responder for fire suppression during fire condition Red. Additionally, Belton Lake forms a natural barrier that protects the two major portions of the GCWA core habitat from total loss due to a catastrophic wildfire.

The proposed let burn policy is anticipated to maintain the fire dynamics within the Live Fire Areas necessary to maintain high quality BCVI habitat and periodically reduce fuel loads that contribute to uncontrolled wildfires. BCVI habitat that burns may become suitable for use by the species within the subsequent five-year period. GCWA habitat that burns would be expected to regenerate to high quality BCVI habitat and further serve as a low-fuel load buffer for remaining GCWA habitats.

Fort Hood has established installation carrying capacity goals of 2,000 territorial GCWA males and 1,000 territorial BCVI males. Carrying capacity is the amount of habitat necessary to support a population at maximum densities. The established habitat requirement to meet these carrying capacity goals is 8,520 ha (21,053 ac) of suitable habitat for GCWAs and 4,170 ha (10,304 ac) of suitable habitat for BCVIs. These minimum habitat requirements are based on results of population viability analyses (USFWS 1996a, USFWS 1996b, Hayden et al. 2001) and meet or exceed regional recovery goals for these species (USFWS 1991, USFWS 1992). Habitat loss anticipated under the proposed action would not significantly affect viability of GCWA or BCVI populations either in terms of available habitat carrying capacity or total population size at Fort Hood.

Installation population goals are expressed as carrying capacity since the associated habitat measure provides a replicable and observable metric for tracking trends over time. This metric is complemented by ongoing demographic monitoring programs that validate parameter estimates on which carrying capacity estimates are based. As demographic parameter estimates or viability analyses are refined, the amount of habitat necessary to meet the carrying capacity goal may be modified, but the goal itself would remain unchanged. The current habitat estimates to meet the established carrying capacity goal is likely a conservative estimate; that is, likely biased toward exceeding the actual habitat required to meet the carrying capacity goals.

2. Reduce Area Designated as 'Core' Habitat

The purpose of designating habitats as "core habitat" is to identify habitat areas that would be subject to the Fort Hood Training Guidelines (Appendix A). The purpose of the training guidelines is to minimize habitat damage and harassment of BCVI and GCWA populations during the breeding season from land-based military training activities. This proposal would eliminate core habitat designation for all BCVI habitats. Core habitat designation for GCWAs would be reduced from the current 14,879 ha (36,767 ac) to the proposed 3,861 ha (9,541 ac). The GCWA core habitat provides a reserve of habitat that is not subject to threats from urbanization, fragmentation, agricultural use, or disturbance from training activities during the breeding season.

The types of military training activities that are restricted under the current training guidelines are not conducted in the Live Fire Areas. Vehicle maneuver, dismounted training, and temporary field training facilities are all conducted in maneuver ranges external to the Live Fire Areas. Endangered species populations in the Live Fire Areas would not be subject to harassment or habitat damage from these training activities. Therefore, core habitat designation for habitats in the Live Fire Areas are largely superfluous given the nature of training activities within this area and serve no purpose to protect populations and habitats.

Potential effects of removing training restrictions in maneuver areas include increased presence of troops and field training facilities in excess of two hours, and vehicles traveling off-road through habitats. These activities could result in increased harassment of individuals, direct mortality, nest loss, and/or damage to habitat as discussed under the effects of Ongoing Activities. Transient vehicle traffic on roads and trails and dismounted troop activity is not expected to increase in response to the proposed action since these activities occur in habitat whether or not it is designated as core habitat.

The reduction in the amount of core habitat for the GCWA is not anticipated to increase habitat fragmentation or isolation as a result of maneuver training activities. Prior to listing in 1990, GCWA habitat was only significantly affected by range clearing activities, such as the one conducted in Training Areas 2 and 4 in the mid 1980s. Such habitat clearing activities are addressed in the proposed programmatic take for such activities (see below).

The proposed action would also reduce the time period for implementing Level 2 restrictions in core habitat from 1 March to 30 June. The current time period for Level 2 restrictions was established to accommodate the breeding season of both the GCWA and BCVI occurring in designated core habitats. Under this proposed action, no BCVI habitat would be designated as core habitat, and therefore, minimization gained from Level 2 restrictions would only apply to the GCWA core habitat. The GCWA nesting and breeding season occurs from the first week of March through July, although some birds may stay as late as August. The majority of nesting behavior and territorial displays occurs from March through June. Few territorial songs are heard after mid-July (Pulich 1976). The proposed changes in the Level 2 time period would accommodate the majority of nesting activity within designated core habitat.

3) Construction and Range Improvements

Under the proposed action, a maximum of 325 ha (803 ac) of endangered species habitat may be permanently lost due to facilities construction and range improvements at Fort Hood. This would directly remove BCVI and GCWA habitat at the project sites and, depending on construction configuration, could lead to increased edge habitat and fragmentation. Effects of these construction activities are generally not equivalent to the impacts associated with urbanization. Typically, the constructed facilities (e.g., MOUT facilities) would have only intermittent human presence. Much of the habitat cleared for range improvements is converted to grassland, which would mimic the landscape matrix associated with non-urban habitats. Since the proposed programmatic take covers several potential projects located throughout the installation, the habitat loss from any one project would likely be on the scale of 10's of hectares. Construction conducted during the nesting season could result in loss of nesting attempts and dislocation of breeding adults.

Assuming a 2:1 ratio of GCWA to BCVI habitat loss under the proposed action, the 325 ha (803 ac) of habitat loss represents 1.0 percent and 1.6 percent of currently available habitat for the GCWA and BCVI, respectively. Construction activities may locally increase fragmentation of associated GCWA habitats including reduced patch size and increased ratio of edge to interior habitat, which may locally have adverse effects on productivity.

Improvements and construction of roads and trails for military training activities may enhance access of troops and vehicles to endangered species habitats. An example would be improved access to hilltop habitats that were not previously accessible. Potential effects of military unit use of endangered species habitats are discussed under the effects of Ongoing Activities.

Planning review by installation natural resource managers provides input on facility siting to minimize impacts on endangered bird habitats. This review occurs early in the planning process. The installation management, monitoring, and research activities described under Ongoing Activities would also assist in minimizing risk to population viability as a result of habitat loss from construction activities.

V. Cumulative Effects

Cumulative effects include the effects of future State, tribal, local or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

At this time, no future state, tribal, local or private actions are known to be planned within the action area. Because the action area encompasses the entire Fort Hood property, any future actions concerning the area would occur at Fort Hood and thus require a separate consultation.

VI. Conclusion

After reviewing the current status of the BCVI and GCWA, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is the Service's biological opinion that the project, as proposed, is not likely to jeopardize the continued existence of the BCVI and GCWA. No critical habitat has been designated for these species, therefore, none would be affected.

The majority of the proposed action is composed of ongoing military training activities in conjunction with endangered species management, monitoring and research. Historically, military training activities have resulted in incidental take of the BCVI and GCWA, which has been well documented. It is anticipated that incidental take would continue to occur at Fort Hood at slightly elevated levels due to the proposed changes in the ESMP that allow the Army more flexibility for the training mission. Even at this elevated level, the years of monitoring and research conducted at Fort Hood indicate that the long term population viability of the BCVI and GCWA within the action area would be sustained. Most importantly, Fort Hood has committed to continue the management of endangered species at population levels that meet the regional recovery goal for each species.

In formulating this biological opinion, the Service considered the effects of the action to continue indefinitely, since the activities are ongoing so long as Fort Hood continues to operate. In so doing, the accompanying Incidental Take Statement addresses the anticipated incidental take associated with the proposed action over five-year periods as totaled from the annual take determination. The annual ‘take’ allowance was calculated based on past events and future needs of the military mission, while ensuring that the potential cumulative impact of the allowed take does not exceed a threshold that would be counter to the population management goals. That is, the amount of habitat loss allowed in the Incidental Take Statement could not exceed the ability to maintain the population goals in successive years. This consideration is especially relevant to the anticipated temporary loss of habitat, which largely occurs from wildfire, and eventually regenerates to suitable habitat for endangered species. Based on these factors, the anticipated incidental take is compatible with long term management of the BCVI and GCWA at Fort Hood.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulations pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity.

Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the Army for the exemption in section 7(o)(2) to apply. The Army has a continuing duty to regulate the activity covered by this Incidental Take Statement. If the Army fails to assume and implement the terms and conditions, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Army must report the progress of the action and its impact on the species to the Service as specified in the Incidental Take Statement. [50 CFR §402.14(i)(3)].

Amount or Extent of Take Anticipated

The Service anticipates that the proposed action would result in the incidental take of BCVIs and GCWAs. Take would be in the form of harm, harassment, wounding, and/or killing. Take, in the form of harm and/or harassment, is difficult to quantify and usually cannot be estimated in terms of numbers of individuals. However, because the area of habitat for both species is known for the action area, the maximum amount of incidental take allowed under this biological opinion is given in terms of habitat area with regard to harm, and nests and/or nesting attempts lost with regard to harassment, wounding and/or killing.

The incidental take exempted in this statement, with the exception of that related to construction and range improvements, is estimated over five-year increments. That is, barring the need for re-initiation, incidental take related to military training and other activities not including construction and range improvements, should not exceed the anticipated levels authorized in this statement within each successive five-year period. Incidental take related to construction and range improvements is authorized over the immediate five-year period following the date this biological opinion is issued.

Based on 11-years of fire data from 1992-2003 (excluding the 1996 catastrophic wildfire), an average of no more than 72 ha (178 ac) of BCVI habitat would be expected to burn annually. Based on the same data set, Fort Hood anticipates that GCWA habitat loss to fire would average 130 ha (321 ac) annually under the let-burn proposal. These estimates represent the upper range of expected fire effects and reflect a "worst" case for habitat loss due to fire under normal environmental, training and fire control procedures as applied under the proposed action.

The estimated incidental take of endangered species due to fire is based on the worst year of habitat loss for each species during the 1992-03 period (excluding 1996) with a multiplier of two to account for the possibility of increased fire frequency and area under the let burn policy. This results in a maximum estimated loss of 650 ha (1606 ac) of GCWA habitat (65 ha/year x 2 x 5 years) over the next and subsequent five-year periods. A maximum loss of 360 ha (890 ac) of BCVI habitat (36 ha/year x 2 x 5 years) is estimated over the next and subsequent five-year periods. These totals comprise 3.0 percent and 5.2 percent of the total habitat currently estimated for GCWAs and BCVIs, respectively. GCWA habitat that regenerates to BCVI habitat after a burn will partially offset loss of BCVI habitats that burn. Additional harm to the GCWA resulting from vehicle training activities within suitable habitat is estimated to be 10 hectares (25 ac) over the next and subsequent five-year periods.

The seven observed instances of BCVI nest loss or potential nest disturbance represent 1.7 percent of the observed nest attempts in the intensively monitored areas. Based on this percent and using conservative estimates of the total number of BCVIs on Fort Hood, mating success, and incidence of re-nesting, it is anticipated that no more than 30 nests annually or 150 nests over five years would be lost by training activity in proximity to nest locations. Take of GCWA through harassment is less likely, but may occur where vehicles and/or personnel frequent the edge of habitat. This low likelihood is anticipated to be less than one percent of nest attempts in habitats not designated as core. Based on a minimum current population estimate of 2,900 territorial males and observed nesting, one percent of nest attempts would equal approximately 25 nests annually or 125 nests over five years.

The proposed action estimates incidental take of endangered species through permanent habitat loss due to construction and range improvements over the next five years. Based on current estimates, it is anticipated that 217 ha (536 ac) of GCWA and 108 ha (267 ac) of BCVI habitat would occur over the next five years as a result of the proposed construction and range improvements. A summary of incidental take authorized in this statement is given in Table 4.

Table 4. Summary of potential incidental take of the black-capped vireo (BCVI) and golden-cheeked warbler (GCWA) resulting from proposed action. Take is estimated in terms of habitat impacts (hectares) and nests and/or nesting attempts lost (nests).

Activity	BCVI	GCWA
Incidental take anticipated from training activities over the next 5-year period and successive 5-year periods.	360 hectares, 150 nests	660 hectares, 125 nests
Incidental take anticipated from construction and range improvements over the next 5-year period.	108 hectares	217 hectares

Effect of the take

In the accompanying biological opinion, the Service determined that the level of anticipated incidental take is not likely to result in jeopardy to the BCVI or GCWA.

Reasonable and Prudent Measures

The Service believes the following reasonable and prudent measures are necessary and appropriate to minimize impacts of incidental take of the GCWA and BCVI:

1) Continue to implement monitoring and research programs for the GCWA and BCVI.

2) Manage vegetation clearing projects to minimize fire hazard from slash, and avoid impacts to residual stands.

3) Emphasize the use of prescribed burning to support protection and maintenance of endangered species habitat, and support ecosystem management principles.

4) Evaluate the effects of predation on endangered species productivity, and investigate management options to reduce nest losses.

5) Monitor the quality and quantity of available endangered species habitat.

6) Incorporate preventative measures to avoid future uncontrolled burns similar to the February 1996 fires.

7) Implement training restrictions in GCWA Core Habitat.

8) Monitor the distribution and spread of oak wilt, and use appropriate measures to limit effects on endangered species habitat.

9) Restrict recreational use in endangered species habitat.

Terms and conditions

In order to be exempt from the prohibitions of section 9 of the Act, the Army must comply with the following terms and conditions, which implement the reasonable and prudent measures described above and outline required reporting/monitoring requirements. These terms and conditions are non-discretionary.

The Service will not refer the incidental take of any migratory bird for prosecution under the Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. §§ 703-712), if such take is in compliance with the terms and conditions (including amount and/or number) specified herein.

1) Continue to implement monitoring and research programs for the GCWA and BCVI.

a) Document population trends and assess population status of the BCVI and GCWA.

b) Evaluate the effects of de-designation of Core Habitat on GCWA and BCVI demography and productivity.

c) Evaluate the relationship between habitat quality and GCWA abundance and productivity.

d) Evaluate fire-related dispersal patterns of GCWAs.

e) Continue to allow safe access to training and Live-Fire Areas for BCVI and GCWA surveys during the period of March 15 through July 31 to ensure that equivalent data is collected for study areas both in and out of the Live Fire Area. It is important that the integrity of data collected from existing BCVI and GCWA productivity, predation and population trend studies is maintained.

f) Continue to generate color sequences for range-wide color banding of BCVI and GCWA through cooperation with the Service.

g) Investigate the dispersal of GCWAs and BCVIs from Fort Hood to surrounding areas through cooperative studies with other researchers and at Corps of Engineers property at Lake Belton and Stillhouse Hollow Lake.

2) Manage vegetation clearing projects to minimize fire hazard from slash, and avoid impacts to residual stands.

a) During juniper clearing or other brush removal projects, construction of firebreaks, power line right of ways, roads, etc., avoid piling material around or against residual standing trees. Ensure that slash material is pulled away from standing live trees and removed from the site, burned, or mulched in place. Slash disposal methods will be included in the scope of proposed projects.

b) Where possible, mulching slash material on site is preferable to removal or burning, in order to return nutrients to the soil and reduce erosion.

c) As an integral part of project design, maximize the use of preventative measures to minimize soil loss after vegetation removal. Examples include re-seeding with native herbaceous plant seed, deferral of grazing from rehabilitation sites, placement of water bars on slopes, and using waste material in gullies as appropriate.

d) All vegetation clearing projects must include coordination with Natural Resources Management Branch from the planning phase forward in order to minimize or avoid impacts to endangered species and their habitat, and must support overall objectives of the INRMP, of which the ESMP is a part.

e) Develop a habitat regeneration/enhancement plan that is compatible with endangered species management and mission training requirements.

3) Emphasize the use of prescribed burning to support protection and maintenance of endangered species habitat, and support ecosystem management principles.

a) All prescribed burning must be overseen by Natural Resources Management Branch personnel certified and experienced in prescribed burning techniques, and support the overall objectives of the INRMP.

b) Identify areas suitable for maintenance as BCVI habitat and implement habitat management prescriptions as necessary.

c) Use prescribed fire to the maximum extent possible to reduce fuel loads near important areas.

d) Use prescribed fire to maintain prairie sites and to inhibit development of pure juniper stands. Fire should be considered as a low-cost, non-invasive means of avoiding future need for destructive large-scale mechanical clearing projects.

4) Evaluate the effects of predation on endangered species productivity, and investigate management options to reduce nest losses.

a) Investigate species-selective methods for control of imported fire ants in endangered species habitat and near important karst features.

b) Continue to control feral hog population utilizing aerial support and trapping, and evaluate effectiveness of control methods.

5) Monitor the quality and quantity of available endangered species habitat.

a) Continue use of helicopter over-flights as needed to ensure compliance with training guidelines, monitor effects of training activity in endangered species habitat, and monitor oak wilt centers.

b) Evaluate habitat trends based on change detection imagery every five years.

c) Maintain adequate natural resource law enforcement presence to effectively monitor land use, and enforce training guidelines and off-road vehicle restrictions.

d) Refine mapping efforts to enhance endangered species information management on Fort Hood.

6) Incorporate preventative measures to avoid future uncontrolled burns similar to the February 1996 fires.

a) Increase fire prevention and response efforts by:

(i) coordinate with the Fire Department and Natural Resource Management Branch during the decision to approve/disapprove Range Condition Red waivers;

(ii) maintain and upgrade fire-fighting capabilities including aerial support, subject to the availability of funds.

b) Continue research on the effects of the 1996 burn.

7) Implement training restrictions in GCWA Core Habitat.

a) Implement *Training Guidelines for Use of Endangered Species Habitat* (Appendix A) at two levels. Level 1 applies from July1 through February 28. Level 2 is more restrictive, and applies from March 1 through June 30.

b) Provide orientation and training for appropriate personnel on the implementation of the guidelines.

8) Monitor the distribution and spread of oak wilt, and use appropriate measures to limit effects on endangered species habitat.

a) Develop and maintain a current map of oak wilt centers, with particular emphasis on training areas where core endangered species habitat occurs.

b) Identify and prioritize oak wilt centers which threaten, or may potentially threaten, core habitat.

c) Investigate treatment and/or isolation methods which might be feasible to limit oak wilt effects.

d) Implement appropriate measures based on priority evaluation.

e) If fungal mats are identified on trees that necessitate removal of that tree during the breeding season, a representative of the Natural Resource Management Branch will be present to ensure that the tree is not being directly utilized by the GCWA as a nesting site. Every effort will be taken to avoid or minimize a direct impact to listed species as a result of management for oak wilt.

f) Investigate the effects of oak wilt on GCWA habitat.

9) Restrict recreational use in endangered species habitat.

Prohibit the use of motorized off-road recreational vehicles in endangered species habitat.

Reporting Requirements

The results of all surveys and studies specified in this biological opinion will be reported to the ARLFO by December 31 of the year the studies are conducted.

Conservation Recommendations

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The following recommendations are provided for consideration by the Army:

1) Fort Hood contains important karst ecosystems that provide habitat for several cave invertebrates and one species of salamander that appear to be endemic. Considering the status of similar karst invertebrates and salamanders endemic to the Edwards Plateau region, Fort Hood is encouraged to continue monitoring and managing the habitat of these species. This would include the development and implementation of a management plan and providing adequate protection of these ecosystems.

2) Fort Hood is encouraged to consider BCVI and GCWA habitat when implementing Compatible Use Buffer activities. This would include extending management and monitoring activities to adjacent lands utilized for buffer purposes when possible.

3) Fort Hood is encouraged to continue work on an off-site conservation plan that would support the on-the-ground work of non-governmental organizations dedicated to the conservation of the BCVI and GCWA.

Reinitiation Notice

This concludes formal consultation on the actions outlined in the request. As provided in 50 CFR § 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operations causing such take must cease pending reinitiation.

The Service appreciates the cooperation extended by the Army staff and participating parties during this consultation. If further assistance or information is required, please contact Mr. Omar Bocanegra or myself at the above address or telephone (817) 277-1100.

Sincerely,

Tom Cloud

Thomas J. Cloud, Jr.
Field Supervisor

cc: State Administrator, Ecological Services, Austin, TX
Regional Director, FWS, Albuquerque, NM (Attn: ARD-ES)

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LAND GROUP (LG)	TRAINING AREAS (TA)					
LG 1	10	11	12	13		
LG 2	20	21	22	23		
LG 3A	34	35	36			
LG 3B	30	31	32	33		
LG 4A	40	41	42			
LG 4B	43	44	45	46	47	48
LG 5A	50	51				
LG 5B	52	53				
LG 6A	60	61	62			
LG 6B	63	64	65			
LG 7	70	71	72	73	74	

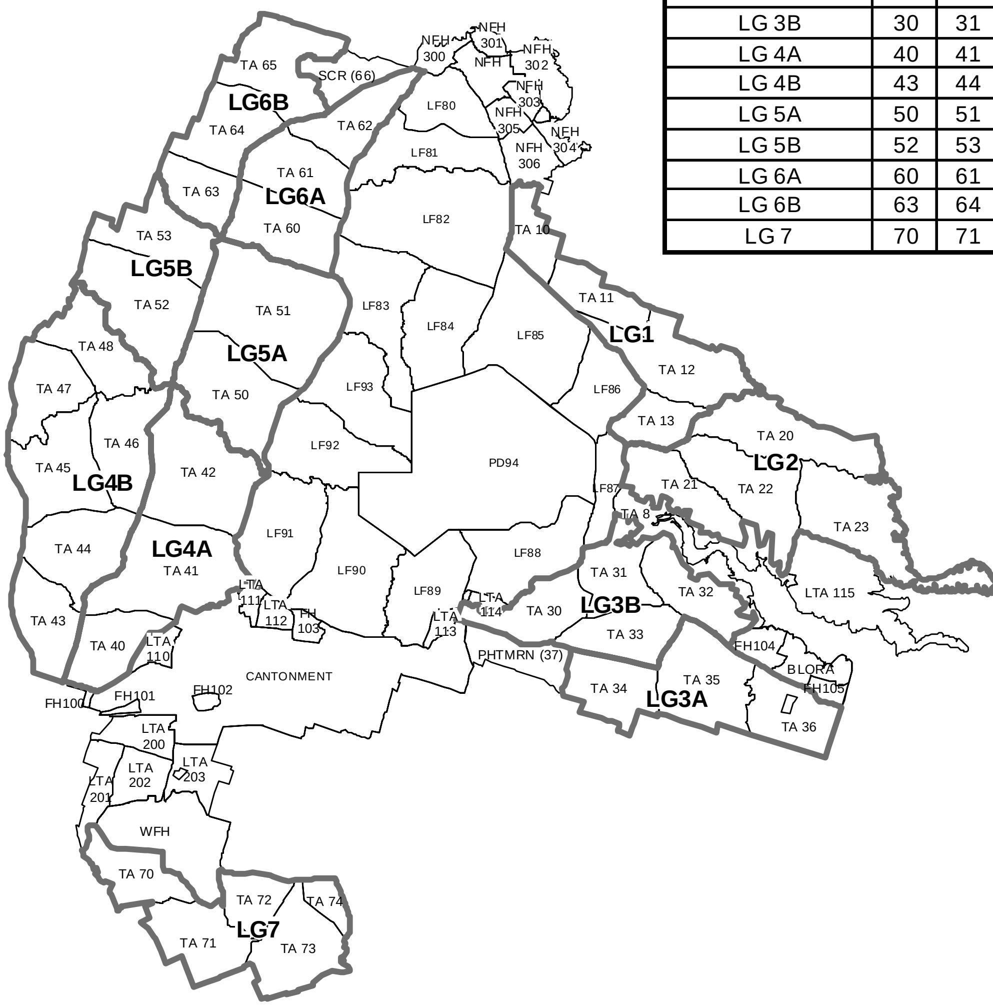

Figure 1. Training Area designations for Fort Hood, Texas. PD = permanently dudded area. LF = live-fire ranges. WFH = West Fort Hood. BLORA = Belton Lake Outdoor Recreation Area.

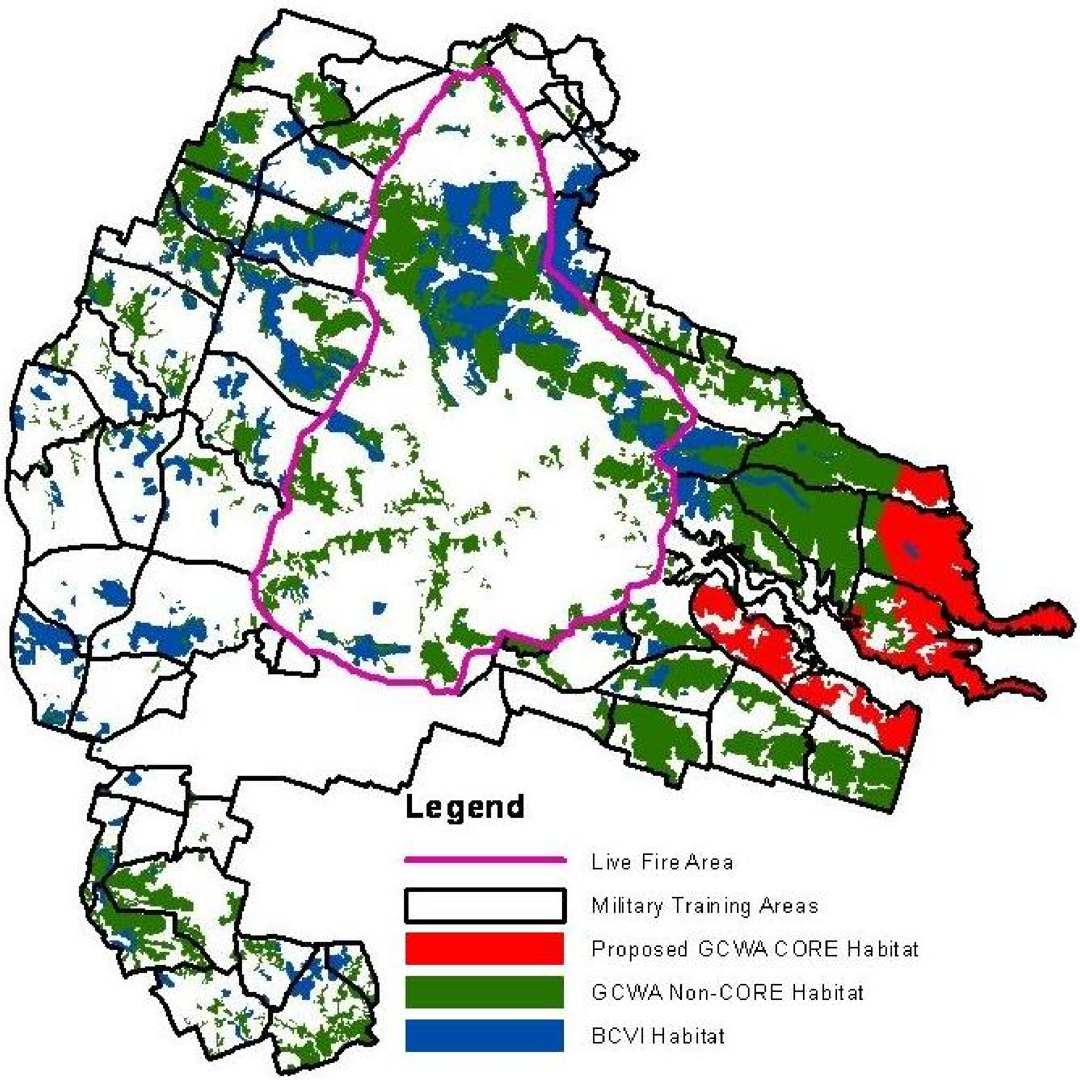

Figure 2. Current distribution of endangered species habitat and GCWA habitats proposed for designation as "core" on Fort Hood, Texas.

APPENDIX A

TRAINING GUIDELINES
FOR USE OF
ENDANGERED SPECIES HABITAT

Guidelines are implemented at two levels. Level 1 applies from 1 July through 28 February. Level 2 is more restrictive, and applies from 1 March through 30 June. The hierarchical structure allows greater utilization of habitat during the period when the endangered species are not present, while providing adequate protection during the nesting period. Guidelines should be used in conjunction with a 1:50,000 training area map with current endangered species habitat overlay.

LEVEL 1 RESTRICTIONS
(applicable from 1 July through 28 February)

1. Report all fires to Range Control. Do not start fires.

2. Use previously established firing points, fighting positions, and emplacements only. All digging must be cleared by the Directorate of Public Works (DPW) through approval of an excavation permit, form FHT 420-X10.

3. Comply with range rules regarding use of flares, incendiary munitions, etc. Ensure that firefighting equipment and personnel on hand are in compliance with Fire Danger Rating SOP.

4. Park equipment in open areas only. Do not cut brush or trees for camouflage, road blocks, or other purposes.

5. Use existing roads and trails. Do not drive vehicles through or over woody vegetation.

6. Do not tamper with, or release birds from, cowbird traps. Traps are serviced regularly and are an essential component of the endangered species management program.

LEVEL 2 RESTRICTIONS
(applicable from 1 March through 30 June)

ALL LEVEL 1 RESTRICTIONS, PLUS THE FOLLOWING:

7. Occupation of habitat areas is limited to drive-through on existing trails, or emergency stop only. No bivouac or other long-term posts are permitted within habitat areas. Long-term is defined as exceeding 2 hours in duration.

NOTE: *Due to difficulty in providing adequate detail at 1:50,000 map scale, habitat overlays sometimes obscure open areas within habitat blocks where some limited long-term use is possible. Proposed use of open areas within habitat must be coordinated with and approved by*

DPW, Natural Resources Management Branch personnel on a case-by-case basis. Arrange for site visit during earliest planning stages (287-2885).

8. No use of obscurant smokes or other chemical agents in or within 100 meters of habitat.

Guidelines are intended to minimize actions which cause physical damage to habitat or disturb nesting. Careful planning and use of current habitat maps are necessary to avoid conflict and possible disruption of training activities in the field. If in doubt regarding acceptable locations or activities in or near habitat, contact DPW, Natural Resources Management Branch at 287-2885.

APPENDIX K

Karst Management Plan

MANAGEMENT PLAN FOR THE CONSERVATION OF RARE KARST SPECIES ON FORT HOOD, BELL AND CORYELL COUNTIES, TEXAS

By

James R. Reddell and George Veni

Introduction

The Fort Hood region is biologically complex. Species living in the region's caves have become physically isolated from each other through time, resulting in genetic isolation that has produced new species known to occur only within small geographic areas. Military activities in the karst areas where these species occur poses a threat to their survival due to potential destruction of caves, sealing of caves, changes in nutrient and moisture input into caves, contaminants introduced into caves, and competition with and predation by non-native species.

A series of cave and karst investigations at Fort Hood have found at least fourteen species of troglobite endemic to Fort Hood:

Spiders	*Cicurina* (*Cicurella*) *caliga* Cokendolpher and Reddell
	Cicurina (*Cicurella*) *coryelli* Gertsch
	Cicurina (*Cicurella*) *hoodensis* Cokendolpher and Reddell
	Cicurina (*Cicurella*) *mixmaster* Cokendolpher and Reddell
	Cicurina (*Cicurella*) *troglobia* Cokendolpher
	Neoleptoneta paraconcinna Cokendolpher and Reddell
Pseudoscorpions	*Tartarocreagris hoodensis* Muchmore
Millipedes:	*Speodesmus castellanus* Elliott
Silverfish:	*Texoreddellia* probable new species
Ground beetles	*Rhadine reyesi* Reddell and Cokendolpher
Ant-like litter beetles:	*Batrisodes* (*Babnormodes*) new species 1
	Batrisodes (*Babnormodes*) *feminiclypeus* Chandler and Reddell
	Batrisodes (*Babnormodes*) *gravesi* Chandler and Reddell
	Batrisodes (*Babnormodes*) *wartoni* Chandler and Reddell

Additionally an undescribed species of slimy salamander of the genus *Plethodon* is currently known only from caves on Fort Hood, but is presumably not cave-restricted. Additional species, presently under study, may also prove to be endemic to Fort Hood and will need to be added to the plan.

The purpose of this investigation is to develop a management plan to conserve the species of concern to meet or exceed the standards recommended by the USFWS for the recovery of listed species and/or the preclusion of listing. These standards are not assurances that the species will not be considered for listing or that listing will be prevented. They are meant to represent sound standards for sustainable survival of the species and preservation of their habitat to the degree possible within the confines of Fort Hood. The USFWS may list some or all of the species if it finds such action is warranted. The inclusion of rare species currently not proposed for listing decreases the likelihood that those species will be petitioned for listing and listed at a later date.

This report follows the format of the USFWS's recovery plan for related endangered karst invertebrates in Travis and Williamson counties, Texas (USFWS, 1994). It is presented in five main parts:

1) Introductory information;
2) Existing conditions, which includes descriptions of the species, their distribution and ecology, the threats to their survival, and conservation measures;
3) Recommended management plan; and
4) References and appendices.

Appendix A is a glossary of geologic, biological, and karst terms used in this report, including taxonomic abbreviations. Appendix B is a conversion index from the International System of Units, used in this report, to English units. Appendix C is a list of cave map symbols.

Project Staff and Contributors

Staff for this project includes cave biologist James R. Reddell, geologist Mike Warton, and karst technician Marcelino Reyes. However, our efforts here represent the cumulative efforts, ideas, and contributions of many people who have worked from 1992 to the present on the Fort Hood cave and karst projects, which were previously cited. We are grateful for all of their assistance.

People who worked on this project include: Doug Allen, James C. Cokendolpher, Jerry Fant, Lee Jay Graves, Jim Killian, Jean Krejca, Dan Love, David McKenzie, Rodney Price, James R. Reddell, Marcelino Reyes, Charley Savvas, Peter Sprouse, Mike Warton, and Bud Wetuski.

Through the course of the cave and karst projects, the following taxonomists have evaluated the cave fauna from Fort Hood for authoritative identification and description of the species: Dr. Donald S. Chandler (ant-like litter beetles), Dr. Kenneth Christiansen (springtails), James C. Cokendolpher (harvestmen, silverfish, ants, and spiders), Dr. William R. Elliott (millipedes), Dr. Richard C. Funk (mites), Dr. Lee Herman (rove beetles), Dr. David Hillis (salamanders), Dr. Horton H. Hobbs, Jr. (ostracods and crayfish), Dr. John R. Holsinger (amphipods), Dr. Julian J. Lewis (asellid isopods), Dr. S.A. Marshall (flies and mosquitoes), Dr. William B. Muchmore (pseudoscorpions), Dr. Stewart B. Peck (leiodid beetles), Dr. George Poinar (nematodes), James R. Reddell (snails, centipedes, cave crickets, and ground beetles), Dr. Rowland M. Shelley (centipedes and millipedes), Dr. W. David Sissom (scorpions), Dr. Charles Triplehorn (darkling beetles), and . Darrell Ubick (harvestmen). James Reddell coordinated the distribution of specimens for identification. Some taxa collected at Fort Hood do not currently have specialists qualified to perform such studies, and those specimens are deposited in the invertebrate zoology collection of the Texas Memorial Museum at the University of Texas in Austin until a specialist becomes available.

Methodology

Work for this project began with reviews of the existing cave and karst research conducted at Fort Hood, any literature related to the species at Fort Hood or to the project, and consultation with other specialists and environmental management personnel in order to collect all existing information relevant to this project. Recommendations from the cave and karst reports were consolidated as appropriate in the management plan, and refined where necessary per the results of more recent research.

Based on the above information, plus the mapped extent of the individual caves' drainage areas as determined in previous studies, this management plan was written to cover general management of the karst areas on Fort Hood, and specific management actions for the species of concern and individual caves containing them. This plan identifies caves of greatest biological significance, with significance determined by each cave's general biodiversity, diversity of species of concern, and the number of localities known for each species of concern. Biological significance is then weighed against the quality of each cave's habitat and its risk of degradation. Management recommendations are provided in order of priority, giving those caves of high biological significance and/or high habitat quality first ranking. Should U.S. Army needs require actions which may impact caves with species of concern, this ranking identifies those caves which would probably be the best to conserve, the areas needed for conservation around each of the caves, and management recommendations for those areas.

This report, its methodology and standards, generally follow the USFWS (1994) recovery plan for endangered cave invertebrates in the Austin, Texas, area. However, this management plan and its recommended actions are not described as "recovery" actions since the species are not currently listed, and also to prevent confusion with recovery actions by the USFWS should any be prescribed at a later date. Some parts of this management plan do not conform to the USFWS (1994) recovery plan where conditions at Fort Hood are not addressed in the recovery plan or are sufficiently different to warrant alternative actions.

Existing Conditions Affecting Species of Concern

Taxonomy, Legal Classification, and Description

Fourteen species of concern are described below. Some have been fully described and named while others await further study and classification. Most of the species do not currently have common names.

Some of the described species below are noted as potentially new species, given their significant distance from other localities where the species have been found and possible anatomical differences. Many of the invertebrate species are identified primarily from a single gender where distinctive differences are present in the genitalia. Adult invertebrate specimens are needed for identification to species level. Possible species of concern may exist in some caves where either the gender that cannot be identified to species level was collected, or where immature specimens were collected but could be identified as troglobites (the category of cave adaptation where rare and endangered species are most likely to occur). In each case, the animal can only be identified to genus. In such situations, the status of the species can only be determined by revisiting the cave, collecting adults for identification, or collecting immature specimens and, if possible, raising them to adulthood in a laboratory. In the future, DNA studies may result in reclassification of some species, as their relationships are better understood.

Species 1 – Scientific name: *Cicurina* (*Cicurella*) *caliga* Cokendolpher and Reddell

Common name: None assigned.

Taxonomic classification: Class Arachnida (arachnids), Order Araneae (spiders), Infraorder Araneomorphae (true spiders), Family Dictynidae. The placement of the genus *Cicurina* in the family Dictynidae is not settled in the literature, although most modern treatments of the genus place it there. The Dictynidae is a diverse group of small to medium sized web spinners known from throughout the world. The cicurinas are unique members of the family on the basis of the lack of two web making structures (cribellum and calamistrum). Taxonomists opposing the placement of the genus in the Dictynidae insist that cicurinas never had the structures, so they did not lose them during evolution. Cicurinas are the only members of the family to have evolved troglobitic members. The genus *Cicurina* was described on the basis of a species from Europe and later species were added from distant countries. The species from North America have been revised several times with the addition of numerous new species. Currently, the genus contains 117 named species, of which one is from northern Europe, seven are from eastern Asia, and 109 are from North America. Almost half of the described species are known only from caves. Cicurinas are known from about 70 epigean and cavernicolous species in Texas. Gertsch (1992), in the latest revision of the genus in North America, recognized 51 species from caves in Texas; of which 46 were true eyeless troglobites.

Original description: Cokendolpher and Reddell (2001).

Type specimens: The female holotype is from Triple J Cave, Nov. 1994 (collected by M. Warton) and is deposited in the American Museum of Natural History. The following paratypes were designated: two females from Triple J Cave, 13 June 2000 (collected by J. Krejca, J. Reddell, M. Reyes, P. Sprouse) and deposited in the Texas Memorial Museum; one female from Triple J Cave, 14 June 2000 (collected by J. Krejca, J. Reddell, M. Reyes, P. Sprouse), and retained in the collection of James C. Cokendolpher; one female from Buchanan Cave, 5 May 1999 (collected by J. Reddell, M. Reyes), and deposited in the Texas Memorial Museum; one female from Streak Cave, 13 June 2000 (collected by J. Krejca, J. Reddell, M. Reyes, P. Sprouse), and deposited in the

Texas Memorial Museum.

Other taxonomic literature: None.

Selected characteristics: A medium sized (about 4.5 mm total length), cream colored, eyeless spider. Specific diagnostic characters pertain to the morphology of the internal genitalia of the female.

Intraspecific variation: No significant variation has been noted.

Distinctiveness: Troglobitic members of the genus *Cicurina* from Texas cannot be distinguished from each other by external body morphology. All are pale colored, eyeless spiders. Currently, species are only recognized by the morphology of the internal female genitalia and hopefully after more males are obtained and studied the morphology of the male palpus will also be used to identify species. Immatures cannot be identified to species. In the field, troglobitic cicurinas are easily confused with the more common *Cicurina varians*. Close examination with a hand lens can separate the two because *C. varians* has eight eyes and the troglobitic species of *Cicurina* are totally eyeless. Cicurinas are the only totally eyeless spiders known from Fort Hood. An undetermined species of *Neoleptoneta* has the eyes very reduced in size, but they are not totally eyeless.

Listing status: The species is not listed as threatened or endangered. It is also not proposed for listing or considered for listing.

Management priority: Based on the available information, the species appears to be limited to a relatively small geographic area. Since such distribution often makes species highly vulnerable to activities in those areas, they are usually considered species of concern by the USFWS.

Species 2 – Scientific name: *Cicurina* (*Cicurella*) *coryelli* Gertsch

Common name: None assigned.

Taxonomic classification: Class Arachnida (arachnids), Order Araneae (spiders), Infraorder Araneomorphae (true spiders), Family Dictynidae. See the taxonomic classification for *Cicurina* (*Cicurella*) *caliga* above.

Original description: Gertsch (1992).

Type specimen: The female holotype is from Tippit Cave, 31 Jan. 1992 (J. Reddell, M. Reyes), and is in the American Museum of Natural History.

Other taxonomic literature: Cokendolpher and Reddell (2001) redescribed the species.

Selected characteristics: A medium sized (about 5 mm total length), cream colored, eyeless spider. Specific diagnostic characters pertain to the morphology of the internal genitalia of the female.

Intraspecific variation: The species ranges in size from about 3.5 to 6 mm total body length.

Distinctiveness: See the distinctiveness for *Cicurina* (*Cicurella*) *caliga* above.

Listing status: The species is not listed as threatened or endangered. It is also not proposed for listing or considered for listing.

Management priority: Based on the available information, the species appears to be limited to a relatively small geographic area. Since such distribution often makes species highly vulnerable to activities in those areas, they are usually considered species of concern by the USFWS.

Species 3 – Scientific name: *Cicurina* (*Cicurella*) *hoodensis* Cokendolpher and Reddell

Common name: None assigned.

Taxonomic classification: Class Arachnida (arachnids), Order Araneae (spiders), Infraorder Araneomorphae (true spiders), Family Dictynidae. See the taxonomic classification for *Cicurina* (*Cicurella*) *caliga* above.

Original description: Cokendolpher and Reddell (2001)

Type specimens: Female holotype from Buchanan Cave, 7 May 1998 (L.J. Graves, J. Reddell, M. Reyes), deposited in the American Museum of Natural History. The following paratypes have been designated: 2 females paratypes from Buchanan Cave, 7 May 1998 (L.J. Graves, J. Reddell, M. Reyes), 1 in the Texas Memorial Museum, 1 in the James C. Cokendolpher collection; 3 female paratypes from Buchanan Cave (4 Nov. 1998 (J. Cokendolpher, J. Krejca, J. Reddell, M. Reyes), in the Texas Memorial Museum; 4 female paratypes from upper level of Buchanan Cave (13 June 2000 (J. Krejca, J. Reddell, M. Reyes, P. Sprouse), 3 in Texas Memorial Museum, 1 in James C. Cokendolpher collection; 1 female paratype from Camp 6 Cave No. 1, 20 April 1998 (L.J. Graves, J. Reddell, M. Reyes), in Texas Memorial Museum; 1 female paratype from Camp 6 Cave No. 1, 2 Nov. 1998 (J. Cokendolpher, J. Reddell), in Texas Memorial Museum; 1 female paratype from Peep in the Deep Cave, 3 Nov. 1998 (J. Cokendolpher, J. Reddell), in Texas Memorial Museum; 1 female paratype from Peep in the Deep Cave, 5 May 1999 (J. Reddell, M. Reyes), in Texas Memorial Museum; 1 female paratype from Talking Crows Cave, 2 Nov. 1998 (M. Reyes), in Texas Memorial Museum; 1 female paratype from Treasure Cave, 2 Nov. 1998 (J. Cokendolpher, J. Reddell, M. Reyes), in Texas Memorial Museum.

Other taxonomic literature: None.

Selected characteristics: A medium sized, cream colored, eyeless spider: body length 3.5 to 5 mm. Specific diagnostic characters pertain to the morphology of the internal genitalia of the female.

Intraspecific variation: Cephalothorax length varies from 1.4 to 2.2 mm, but there does not appear to be any correlation in size difference between caves.

Distinctiveness: See the distinctiveness for *Cicurina* (*Cicurella*) *caliga* above.

Listing status: The species is not listed as threatened or endangered. It is also not proposed for listing or considered for listing.

Management priority: Based on the available information, the species appears to be limited to a relatively small geographic area. Since such distribution often makes species highly vulnerable to activities in those areas, they are usually considered species of concern by the USFWS.

Species 4 – Scientific name: *Cicurina* (*Cicurella*) *mixmaster* Cokendolpher and Reddell

Common name: None assigned.

Taxonomic classification: Class Arachnida (arachnids), Order Araneae (spiders), Infraorder Araneomorphae (true spiders), Family Dictynidae. See the taxonomic classification for *Cicurina* (*Cicurella*) *caliga* above.

Original description: Cokendolpher and Reddell (2001).

Type specimen: The female holotype is from Mixmaster Cave, 5 Nov. 1998 (J. Cokendolpher, J. Krejca, J. Reddell, M. Reyes), in American Museum of Natural History.

Other taxonomic literature: None.

Selected characteristics: A medium sized (about 6.3 mm total length), cream colored, eyeless spider. Specific diagnostic characters pertain to the morphology of the internal genitalia of the female.

Intraspecific variation: No information is available.

Distinctiveness: See the distinctiveness for *Cicurina* (*Cicurella*) *caliga* above.

Listing status: The species is not listed as threatened or endangered. It is also not proposed for listing or considered for listing.

Management priority: Based on the available information, the species appears to be limited to a very small geographic area. Since such distribution often makes species highly vulnerable to activities in those areas, they are usually considered species of concern by the USFWS.

Species 5 – Scientific name: *Cicurina* (*Cicurella*) *troglobia* Cokendolpher

Common name: None assigned.

Taxonomic classification: Class Arachnida (arachnids), Order Araneae (spiders), Infraorder Araneomorphae (true spiders), Family Dictynidae. The placement of the genus *Cicurina* in the family Dictynidae is not settled in the literature, although most modern treatments of the genus place it there. The Dictynidae is a diverse group of small to medium sized web spinners known from throughout the world. The cicurinas are unique members of the family on the basis of the lack of two web making structures (cribellum and calamistrum). Taxonomists opposing the placement of the genus in the Dictynidae insist that cicurinas never had the structures, so they did not lose them during evolution. Cicurinas are the only members of the family to have evolved troglobitic members. The genus *Cicurina* was described on the basis of a species from Europe and later species were added from distant countries. The species from North America have been revised several times with the addition of numerous new species. Currently, the genus contains 117 named species, of which one is from northern Europe, seven are from eastern Asia, and 109 are from North America. Almost half of the described species are known only from caves. Cicurinas are known from about 70 epigean and cavernicolous species in Texas. Gertsch (1992), in the latest revision of the genus in North America, recognized 51 species from caves in Texas; of which 46 were true eyeless troglobites.

Original description: Cokendolpher (2004).

Type specimens: The female holotype is from Seven Mile Mountain Cave, 28 June 2000 (J. Reddell, M. Reyes), deposited in the American Museum of Natural History.

Other taxonomic literature: None.

Selected characteristics: A medium sized (about 5 mm total length), cream colored, eyeless spider. Specific diagnostic characters pertain to the morphology of the internal genitalia of the female.

Intraspecific variation: No significant variation has been noted.

Distinctiveness: See the distinctiveness for *Cicurina* (*Cicurella*) *caliga* above.

Listing status: The species is not listed as threatened or endangered. It is also not proposed for listing or considered for listing.

Management priority: Based on the available information, the species appears to be limited to a relatively small geographic area. Since such distribution often makes species highly vulnerable to activities in those areas, they are usually considered species of concern by the USFWS.

Species 6 – Scientific name: *Neoleptoneta paraconcinna* Cokendolpher and Reddell

Common name: None assigned.

Taxonomic classification: Class Arachnida (arachnids), Order Araneae (spiders) Infraorder Araneomorphae (true spiders), Family Leptonetidae. The leptonetids are small to minute spiders restricted to subterranean and litter habitats in the Mediterranean area (65 species), eastern Asia (60 species), and Central (one species) and North America (45 species). Gertsch (1974) revised the North American fauna. Most species worldwide are known from cave habitats. Because of their small size and uniform general morphology, characters for separating species are difficult to locate and examine. The morphology of the male genitalia appears to be most significant. Gertsch (1974) described or redescribed the eight species known from caves in Texas in the genus *Leptoneta*. Later, Brignoli (1983) transferred the Texas *Leptoneta* to *Neoleptoneta*.

Original description: Cokendolpher and Reddell (2001).

Type specimen: The holotype male is from Peep in the Deep Cave, 21 April 1998 (J. Reddell, M. Reyes), in the American Museum of Natural History. The following paratypes have been designated: 1 female paratype from Peep in the Deep Cave, 21 April 1998 (J. Reddell, M. Reyes), in the Texas Memorial Museum; 1 male paratype from Camp 6 Cave No. 1, 5 May 1999 (J. Reddell, M. Reyes), in the Texas Memorial Museum; 1 female paratype from Figure 8 Cave, 20 April 1998 (L.J. Graves, J. Reddell, M. Reyes), in the Texas Memorial Museum.

Other taxonomic literature: None.

Selected characteristics: A minute (body length 1-2 mm), light tan to straw colored, 6-eyed spider. Other specific characters pertain to the morphology of the internal genitalia of the female and the palpus of the male.

Intraspecific variation: No data are available at this time.

Selected characteristics: This six-eyed spider has a minute body length of 1-2 mm, and is light tan to straw colored. Other specific characters pertain to the morphology of the internal genitalia of the female and the palpus of the male.

Distinctiveness: Troglobitic members of the genus *Neoleptoneta* from Texas cannot be distinguished from each other by external body morphology, except to some extent by the size of the eyes and the ratios of the appendages to the body. All are minute, pale colored spiders. Currently, species are only recognized by the morphology of the male genitalia and to a much lesser extent the internal female genitalia. Immatures cannot be identified to species. In the field, neoleptonetids are easily confused with early instar immatures of other spiders because of their small size. A hand lens generally does not provide sufficient magnification for the inexperienced to verify a spider as a leptonetid. With some practice, neoleptonetids can be recognized by the presence of only six eyes (4 in a row on the front edge of the cephalothorax, followed by a centrally located pair). Some females from Peep in the Deep Cave have the eyes reduced and lack pigment around the eyes. Until males with similar characteristics are found it is not known if these specimens belong to *N. paraconcinna* or represent a second species. They cannot be distinguished in the field.

Management priority: Based on the available information, the species appears to be limited to a relatively small geographic area. Since such distribution often makes species highly vulnerable to activities in those areas, they are usually considered species of concern by the USFWS.

Species 7 – Scientific name: *Tartarocreagris hoodensis* Muchmore

Common name: None assigned.

Listing status: The species is not listed as threatened or endangered. It is also not proposed for listing or considered for listing. However, this status may change once it has been fully described

Taxonomic classification: Class Arachnida (arachnids), Order Pseudoscorpionida (pseudoscorpions), Family Neobisiidae. The genus *Tartarocreagris* includes 14 species, of which 11 are probably troglobitic. The genus is largely restricted to caves along the Balcones Fault Zone, but one surface species has been found in Arkansas, and two occur both on the surface and in caves in Texas, and an undescribed species was collected from Fannin County, Texas.

Original description: Muchmore (2001).

Type specimens: Female holotype from Chigiouxs' Cave, 21 November 1995 (J. Reddell, M. Reyes), in Florida State Collection of Arthropods; allotype male from Buchanan Cave, 4 November 1998 (J.C. Cokendolpher, J. Krejca, J. Reddell, M. Reyes), in Florida State Collection of Arthropods; paratype female from Rugger's Rift Cave, 5 November 1998 (J. Reddell, M. Reyes), in Florida State Collection of Arthropods.

Other taxonomic literature: None.

Selected characteristics: This is a small to medium-sized (body length 2.60 to 2.73 mm), eyeless species with palpal femur 0.70-0.90 mm, and length/breadth ratio of hand about 1.4.

Intraspecific variation: There is no notable variation between populations in this species.

Distinctiveness: This species can be distinguished from closely related species only by microscopic examination of slide-mounted specimens.

Listing status: The species is not listed as threatened or endangered. It is also not proposed for listing or considered for listing.

Management priority: Based on the available information, the species appears to be limited to a relatively small geographic area. Since such distribution often makes species highly vulnerable to activities in those areas, they are usually considered species of concern by the USFWS.

Species 8 – Scientific name: *Speodesmus castellanus* Elliott

Common name: Fort Hood cave millipede.

Taxonomic classification: Class Diplopoda (millipedes), Order Polydesmida, Family Fuhrmannodesmidae. Members of the order Polydesmida are all eyeless Usage of the family Fuhrmannodesmidae is somewhat questionable. At various times, the genera now placed in this family have been placed in the families Polydesmidae and Vanhoefeniidae. The genus *Speodesmus* includes only troglobites and there are three described species. *Speodesmus bicornourus* Causey is known from northern Travis and Williamson County; *S. echinourus* Loomis is a widespread species throughout southern parts of the Balcones Fault Zone and eastern Edwards Plateau; *S. tuganbius* (Chamberlin) occurs in the gypsum plain of Culberson County and parts of eastern New Mexico. Several undescribed species are known from throughout Texas.

Original description: Elliott (2004).

Type specimens: Male holotype from Rocket River Cave, 16 January 1992 (L.J.Graves, C. Savvas), deposited in the United States National Museum of Natural History. Female allotype and two male paratypes with same data also deposited in the United States Museum of Natural History. Two male paratypes deposited in the Texas Memorial Museum.

Other taxonomic literature: None.

Selected characteristics: A small delicate white species of the genus (body length about 8 mm).

Intraspecific variation: Body length varies from 8 to 11 mm.

Distinctiveness: Currently, members of the genus *Speodesmus* can only be recognized with certainty by examination of the male genitalia. Because of this, no females or juveniles can be identified to species unless they are associated with adult males. The species included here is the only member of the genus on Fort Hood. The only other troglobitic millipede on Fort Hood is *Cambala speobia* (Chamberlin). This is a round, pigmented species with short legs. It also frequently rolls into a tight coil when disturbed.

Listing status: The species is not listed as threatened or endangered. It is also not proposed for listing or considered for listing.

Management priority: Based on the available information, the species appears to be limited to a relatively small geographic area. Since such distribution often makes species highly vulnerable to activities in those areas, they are usually considered species of concern by the USFWS.

Species 9 – Scientific name: *Texoreddellia* probable new species

Common name: None assigned.

Taxonomic classification: Class Insecta, Order Thysanura, Family Nicoletiidae. The genus *Texoreddellia* contains only one described species, *T. texensis* (Ulrich). The genus ranges throughout the Balcones Fault Zone and Edwards Plateau, with isolated populations in western Texas. Recent studies indicate that several species are probably present. All known populations of the genus are troglobitic.

Original description: The species is undescribed. It is known only from two caves on Fort Hood.

Type specimen: No type specimen exists.

Other taxonomic literature: None.

Selected characteristics: This is about 10 mm long, white, and eyeless. It has shorter appendages than other populations in karst areas to the south.

Intraspecific variation: No information is available.

Distinctiveness: This is the only troglobitic silverfish on Fort Hood. The only other silverfish is a much smaller species found in association with fire ants. It is readily distinguished from *Texoreddellia* by its short legs and more triangular body shape.

Listing status: The species is not listed as threatened or endangered. It is also not proposed for listing or considered for listing.

Management priority: Based on the available information, the species appears to be limited to a relatively small geographic area. Since such distribution often makes species highly vulnerable to activities in those areas, they are usually considered species of concern by the USFWS.

Species 10 - Scientific name: *Rhadine reyesi* Reddell and Cokendolpher

Common name: None assigned.

Taxonomic classification: Class Insecta (insects), Order Coleoptera (beetles), Suborder Adephaga, Family Carabidae (ground beetles). The family Carabidae is one of the larger families of beetles and is found worldwide in almost every terrestrial habitat. The vast majority of troglobitic beetles belong to this family. The genus *Rhadine* contains more than 60 eyed and eyeless species in the Great Plains westward to California and south to Oaxaca, Mexico. Twelve described and several undescribed species are troglobites found mostly in caves of the Balcones Escarpment of Central Texas (Barr, 1964; Reddell and Cokendolpher, 2001b). All are members of the *subterranea* species group, a monophyletic assemblage. This group is closely related to the *perlevis* group, which contains eyed, troglophilic members found in caves of the Edwards Plateau and southern Balcones Fault Zone. The *subterranea* group contains a "robust," or heavy-bodied, subgroup and a "slender" subgroup. *Rhadine reyesi* belongs to the "robust" group of species.

Original description: Reddell and Cokendolpher (2001b).

Type specimens: Male holotype from Tippit Cave, 8 April 1999 (M. Reyes), in the American Museum of Natural History. The following paratypes have been designated: One paratype female from Tippit Cave, 8 April 1999 (M. Reyes), in the American Museum of Natural History; one paratype male from Tippit Cave, 8 April 1999 (M. Reyes), in the Texas Memorial Museum; one paratype male from Tippit Cave, 8 April 1999 (L.J. Graves), in the Texas Memorial Museum; one paratype male from Tippit Cave, 31 Jan. 1992 (J. Reddell, M. Reyes), in the Texas Memorial Museum; two paratype males from Tippit Cave, 9 Feb. 1992 (J. Reddell, M. Reyes), in the Texas Memorial Museum; three paratype males and three paratype females, 3 Nov. 1992 (J. Reddell, M. Reyes), in the Texas Memorial Museum; one paratype female, 6 Nov. 1992 (J. Reddell, M. Reyes), in the Texas Memorial Museum; one paratype male and one paratype female, 16 July 1993 (D. McKenzie, J. Reddell, M. Reyes), in the University of Texas A&M.

Other taxonomic literature: There are no additional references to this species.

Selected characteristics: Reddish-brown; total length 8.28 to 9.94 mm long, eye rudiments large (about 0.12 x 0.20 mm); robust (neck 0.67-0.78 narrower than greatest head width; pronotum about 0.6 longer than wide; elytra about twice longer than wide); without pronotal setae.

Intraspecific variation: There is no significant variation.

Distinctiveness: This is the only species of *Rhadine* on Fort Hood.

Listing status: The species is not listed as threatened or endangered. It is also not proposed for listing or considered for listing.

Management priority: Based on the available information, the species appears to be limited to a relatively small geographic area. Since such distribution often makes species highly vulnerable to activities in those areas, they are usually considered species of concern by the USFWS.

Species 11– Scientific name: *Batrisodes* (*Babnormodes*) new species 1

Common name: None assigned.

Taxonomic classification: Class Insecta (insects), Order Coleoptera (beetles), Suborder Adephaga, Family Staphylinidae, Subfamily Pselaphinae (ant-like litter or mold beetles).). The subfamily family Pselaphinae is a distinctive assemblage of beetles and is found worldwide in almost every terrestrial habitat. Many troglobitic beetles belong to this subfamily. The genus *Batrisodes* contains many blind and eyed species. Eight described and two undescribed species are troglobites in Texas caves. A closely related genus *Texamaurops* contains only one species, *T. reddelli* Barr and Steeves, from caves on the Jollyville Plateau of Travis County. *Texamaurops reddelli*, *Batrisodes* (*Excavodes*) *texanus* Chandler, and *Batrisodes* (*Excavodes*) *venyivi* Chandler are on the USFWS Endangered Species List. With the exception of the four species from Fort Hood, all species of troglobitic *Batrisodes* belong to the subgenus *Excavodes*.

Original description: The species is undescribed. It is known only from one cave on Fort Hood.

Type specimen: No type specimen has been designated.

Other taxonomic literature: There are no references to this species.

Selected characteristics: Small (body length about 2 mm); reddish-brown. Other characters require microscopic examination of morphological details.

Intraspecific variation: Only one specimen is known.

Distinctiveness: This species cannot be separated from other species on Fort Hood except through microscopic examination.

Listing status: The species is not listed as threatened or endangered. It is also not proposed for listing or considered for listing. However, this status may change once it has been fully described.

Management priority: Based on the available information, the species appears to be limited to a relatively small geographic area. Since such distribution often makes species highly vulnerable to activities in those areas, they are usually considered species of concern by the USFWS.

Species 12 – Scientific name: *Batrisodes* (*Babnormodes*) *feminiclypeus* Chandler and Reddell

Common name: None assigned.

Taxonomic classification: Class Insecta (insects), Order Coleoptera (beetles), Suborder Adephaga, Family Staphylinidae, Subfamily Pselaphinae (ant-like litter or mold beetles).). The subfamily family Pselaphinae is a distinctive assemblage of beetles and is found worldwide in almost every terrestrial habitat. Many troglobitic beetles belong to this subfamily. The genus *Batrisodes* contains many blind and eyed species. Eight described and two undescribed species are troglobites in Texas caves. A closely related genus *Texamaurops* contains only one species, *T. reddelli* Barr and Steeves, from caves on the Jollyville Plateau of Travis County. *Texamaurops reddelli*, *Batrisodes* (*Excavodes*) *texanus* Chandler, and *Batrisodes* (*Excavodes*) *venyivi* Chandler are on the USFWS Endangered Species List. With the exception of the four species from Fort Hood, all species of troglobitic *Batrisodes* belong to the subgenus *Excavodes*.

Original description: Chandler and Reddell (2001).

Type specimen: Male holotype from Skeeter Cave, 18 May 1999 (L.J. Graves, J. Reddell, M. Reyes), in the Field Museum of Natural History. The following paratypes have been designated: one male, three males from Skeeter Cave, 18 May 1999 (L.J. Graves, J. Reddell, M. Reyes), in the Texas Memorial Museum.

Other taxonomic literature: None.

Selected characteristics: A very small (body length 2.29-2.48 mm) reddish-brown beetle. Other characters require microscopic examination of morphological details.

Intraspecific variation: No significant variation is present.

Distinctiveness: This species cannot be separated from other members of the genus on Fort Hood without microscopic examination.

Listing status: The species is not listed as threatened or endangered. It is also not proposed for listing or considered for listing.

Management priority: Based on the available information, the species appears to be limited to a relatively small geographic area. Since such distribution often makes species highly vulnerable to activities in those areas, they are usually considered species of concern by the USFWS.

Species 13 – Scientific name: *Batrisodes* (*Babnormodes*) *gravesi* Chandler and Reddell

Common name: None assigned.

Taxonomic classification: Class Insecta (insects), Order Coleoptera (beetles), Suborder Adephaga, Family Staphylinidae, Subfamily Pselaphinae (ant-like litter or mold beetles). See the taxonomic classification for *Batrisodes* (*Babnormodes*) n.sp. above.

Type specimens: Holotype male from Streak Cave, 26 Sept. 1997 (L.J. Graves, J. Reddell, M.

Reyes), in Field Museum of Natural History. The following paratypes have been designated: four females from Streak Cave, 6 Oct. 1995 (M. Warton); one female from Buchanan Cave, 7 May 1998 (L.J. Graves, J. Reddell, M. Reyes); one male from Bumelia Well Cave, 28 Oct. 1994 (D. Allen, D. Love); 1 male from Bumelia Well Cave, 4 Nov. 1998 (J. Cokendolpher, J. Krejca, J. Reddell, M. Reyes); 1 male from Figure 8 Cave, 9 Feb. 1996 (M. Warton); 1 female from Lucky Rock Cave, 10 Sept. 1997 (L.J. Graves, J. Reddell, M. Reyes); 1 male from Price Pit Cave, 6 May 1999 (J. Reddell, M. Reyes); 1 female from Triple J Cave, 4 Oct. 1995 (M. Warton); 3 males from Triple J Cave, 23 April 1998 (L.J. Graves, J. Reddell, M. Reyes); 1 female from Keyhole Cave, 6 May 1999 (J. Reddell, M. Reyes); 1 female from Mixmaster Cave, 5 Nov. 1998 (J. Cokendolpher, J. Krejca, J. Reddell, M. Reyes.).

Other taxonomic literature: None.

Selected characteristics: A small (body length 2.32-2.64 mm) reddish-brown beetle. Other characters require microscopic examination of morphological details.

Intraspecific variation: No significant variation has been observed.

Distinctiveness: This species cannot be separated from other members of the genus on Fort Hood without microscopic examination.

Listing status: The species is not listed as threatened or endangered. It is also not proposed for listing or considered for listing.

Management priority: Based on the available information, the species appears to be limited to a relatively small geographic area. Since such distribution often makes species highly vulnerable to activities in those areas, they are usually considered species of concern by the USFWS.

Species 14 – Scientific name: *Batrisodes* (*Babnormodes*) *wartoni* Chandler and Reddell

Common name: None assigned.

Taxonomic classification: Class Insecta (insects), Order Coleoptera (beetles), Suborder Adephaga, Family Staphylinidae, Subfamily Pselaphinae (ant-like litter or mold beetles). See the taxonomic classification for *Batrisodes* (*Babnormodes*) n.sp. above.

Original description: Chandler and Reddell (2001).

Type specimens: Holotype male from Rocket River Cave, 27 Oct. 1994 (M. Warton), in Field Museum of Natural History. The following paratypes have been designated: 1 female from Chigiouxs' Cave, 21 Nov. 1995 (J. Reddell, M. Reyes); 2 females from Tippit Cave, 9 Feb. 1992 (J. Reddell, M. Reyes); 1 male from Tippit Cave, 31 Jan. 1992 (J. Reddell, M. Reyes); 1 female from Tippit Cave, 3 Nov. 1992 (J. Reddell, M. Reyes); 1 female from Tippit Cave, 6 Nov. 1992 (J. Reddell, M. Reyes); three females from Tippit Cave, 1 July 1993 (D. McKenzie, J. Reddell, M. Reyes).

Other taxonomic literature: None.

Selected characteristics: A small (body length 2.08-2.24 mm), reddish-brown beetle... Other characters require microscopic examination of morphological details.

Intraspecific variation: No significant variation has been observed.

Distinctiveness: This species cannot be separated from other members of the genus on Fort Hood without microscopic examination.

Listing status: The species is not listed as threatened or endangered. It is also not proposed for listing or considered for listing.

Management priority: Based on the available information, the species appears to be limited to a relatively small geographic area. Since such distribution often makes species highly vulnerable to activities in those areas, they are usually considered species of concern by the USFWS.

Species 15 – Scientific name: *Plethodon* new species

Common name: None assigned.

Taxonomic classification: Class Amphibia, Order Urodela (salamanders), Family Plethodontidae. The family Plethodontidae is the largest family of salamanders. Most species are terrestrial, but a few cave forms have invaded the aquatic habitat and become paedogenetic. The genus *Plethodon* contains numerous species from throughout the United States and they are frequently found in caves.

Original description: A description of this species is in preparation by Dr. David Hillis of the University of Texas.

Type specimen: No type specimen has been designated.

Other taxonomic literature: None.

Selected characteristics: Solid black with a heavy coating of mucus on the body.

Intraspecific variation: No data are available.

Distinctiveness: This is the only species of terrestrial salamander on Fort Hood. The only other described species of *Plethodon* in Central Texas is *P. albagula* Grobman. This species has been reported from caves and other sheltered terrestrial habitats from southern Williamson County south to Bexar County and west to Real County. A distinct white throat and rows of silvery spots along the sides of the body as opposed to the solid black color of the Fort Hood species characterize it.

Listing status: The species is not listed as threatened or endangered. It is also not proposed for listing or considered for listing.

Management priority: Based on the available information, the species appears to be limited to a relatively small geographic area. Since such distribution often makes species highly vulnerable to activities in those areas, they are usually considered species of concern by the USFWS.

Species Distribution

Population Estimates

Population estimates for the species of concern are not available due to their inaccessibility, rarity, and sometime secretive habits. Some species are so secretive and/or their populations so small that even with repeated visits to a cave they may rarely be seen. Seasonal changes in cave microclimatic conditions also affect the likelihood of observing the species. During prolonged periods without rain, or when cold winter air sinks in, caves become drier, and invertebrate species retreat into moister and warmer soils and fractures that are humanly inaccessible.

There have been no monitoring studies conducted on Fort Hood that would provide quantitative information on seasonal abundance or population sizes of any of the species of concern. A few studies have been conducted in other areas, although none have been formally published.

Some of the limitations on observing the species of concern were quantified during the biological monitoring of four Camp Bullis caves from October 1995 through April 1998 (Veni et al., 1996, 1998a, 1998b). Each cave was monitored quarterly. The numbers of individuals observed during a particular monitoring trip were found to correlate to seasonal changes and total annual rainfall, and were generally more abundant during moister conditions. The secretiveness of some species was well demonstrated by the one-time discovery of *Mixojapyx* sp. in Platypus Pit, despite 12 intensive searches for species during the monitoring effort and three preceding careful searches for fauna. Even widely roaming and generally more visible species like *Rhadine* beetles could be rare during certain periods. If rarity in a certain cave proves consistent, it suggests a small population.

The monitoring trips were not intended to make statistically reliable population estimates of each species. Instead, they recorded numbers representative of relative abundance and “observability” which could be graphed to aid in understanding the overall picture of a cave’s ecology. Precise population estimates were considered beyond the scope of the study and potentially harmful to the populations. Traditional population measuring techniques, such as marking and recapturing of specimens and quadrant sampling, can be disruptive to small cave communities. For extremely small populations, classical population estimates would not be reliable and could even kill marked specimens. The counts were representative of what a cave biologist would find during an intensive survey, in which each type of microhabitat would be thoroughly searched and specimens collected.

Table 1 provides average approximations of observability of the species of concern based on the biological monitoring studies and studies in other caves for species that do not occur in the four caves monitored. These approximations assume generally favorable conditions and intensive searches for the species. They are not meant to represent populations or conditions in any particular cave. The intent is to provide at least a gross measure of species' abundance to somewhat quantify the hard-to-quantify data, and as a baseline for future research. The biological monitoring indicated that another general measure of cave species populations is to count cave crickets as they exit caves nightly to forage. Results from the monitoring reveal that while cricket counts cannot suggest the presence or absence of other specific species, higher cricket counts usually occur with more diverse cave ecosystems with greater observable abundances of individual species.

Table 1

TYPICAL NUMBERS OF SPECIES OF CONCERN OBSERVED DURING FAVORABLE CONDITIONS BY INTENSIVE BIOLOGICAL SURVEYS

Species of concern	Typical numbers observed
Cicurina (Cicurella) n. sp. 1	0-1
Cicurina (Cicurella) n. sp. 2	0-1
Cicurina (*Cicurella*) *madla*	1-5
Neoleptoneta n. sp.	0-3
Tartarocreagris n. sp.	0-4
Texella n. sp. 1	0-1
Texella n. sp. 2	0-1
Texella n. sp. 3	0-1
Mixojapyx sp.	0-1
Rhadine sp. 1	1-3
Rhadine sp. 2	1-2
Rhadine exilis	2-4
Rhadine infernalis	2-5
Eurycea sp.	1-2
Eurycea tridentifera	1-2

Historic Range

There is no information on the ranges of the species of concern on Fort Hood prior to our aforementioned cave and karst studies, which began in 1990. None of the species of concern considered for this plan occur outside of Fort Hood.

Current Range

The primary source of information on the distribution of the species of concern at Fort Hood is a previous report (Reddell, 2002).

<u>Delineation of Karst Fauna Regions and Subregions at Fort Hood</u>

Despite recent intensive study of the species of concern, additional research continues to discover new localities and better define the ranges of the animals. However, the general ranges of the proposed invertebrates have been delimited based on geologic factors that would fully or partly confine populations to certain areas, and the new localities occur within those ranges.

There are apparently no detailed geologic maps that outline the distribution of the cavernous limestone on Fort Hood. The approximate boundaries of the Edwards Limestone (the only significant cavernous formation on Fort Hood) have been traced onto to topographic maps. Field observations indicate that there are areas shown as Edwards Limestone that are in fact not. It is also possible that areas of Edwards Limestone are not indicated on the maps. The following karst fauna regions have been identified on Fort Hood based on isolation of Edwards Limestone outcrops. These are in turn subdivided into subregions based on possible barriers to faunal distributions.

North Nolan Creek Region
Seven Mile Mountain Region
North Fort Hood Region
- Northeast Fort Hood Subregion
- Rocket River Cave Subregion
- Egypt Hollow Subregion
- West Fort Hood Subregion

The following descriptions of the regions and subregions provide the biological and hydrogeologic justifications for these designations and revisions. Table 2 lists the species of concern by the caves, regions, and subregions in which they occur; Table 3 provides the legend to abbreviations used in Table 2. The regions and subregions, along with the distribution of the species of concern, are shown in Figures 1-7.

Table 3

LEGEND FOR ABBREVIATIONS USED IN TABLE 2

Full name or title	*Abbreviation*
Cicurina (*Cicurella*) *caliga*	C2
Cicurina (*Cicurella*) *coryelli*	C3
Cicurina (*Cicurella*) *hoodensis*	C4
Cicurina (*Cicurella*) *mixmaster*	C5
Cicurina (*Cicurella*) *troglobia*	C1
Neoleptoneta paraconcinna	N
Tartarocreagris hoodensis	TH
Speodesmus n. sp.	S
Texoreddellia probable n. sp.	TX
Rhadine reyesi	R
Batrisodes (*Babnormodes*) n. sp.	B1
Batrisodes (*Babnormodes*) *feminiclypeus*	B2
Batrisodes (*Babnormodes*) *gravesi*	B3
Batrisodes (*Babnormodes*) *wartoni*	B4
Plethodon n. sp.	P
Solenopsis invicta	FA
Total number of species of concern	TSOC
Species presence confirmed	X
Species presence tentative	T

North Nolan Creek Karst Fauna Region. This region comprises outcrops of the Edwards Limestone located south of Cow House Creek and extending from Lake Belton on the east to Post Oak Mountain on the west. Most of the limestone in this area is thin and few caves are known in the region.

The only species of concern currently recognized for this region is the silverfish *Texoreddellia* new species. This may be identical to specimens from the Seven Mile Mountain Fauna Region, but adequate material is not available for a final determination.

Seven Mile Mountain Karst Fauna Region. This region comprises outcrops of the Edwards Limestone on Seven Mile Mountain in extreme southwest Fort Hood. Only one cave and one sinkhole are known on the part of Seven Mile Mountain located on Fort Hood. A report of other caves on the northern part of Seven Mile Mountain has not been verified. The only species of concern known from this area are the spider, *Cicurina* (*Cicurella*) *troglobia* and the silverfish *Texoreddellia* new species. It is not currently possible to determine if the population of *Texoreddellia* is conspecific with that in the North Nolan Creek Fauna Region.

North Food Hood Karst Fauna Region. This area is defined as all outcrops of the Edwards Limestone north of Cow House Creek and extending from Lake Belton on the east to the western boundary of Fort Hood. Based on the rough geologic map available, this appears to be a contiguous area of Edwards Limestone. One small gap in the limestone is known to occur where East Range Road crosses the outcrop immediately south of Owl Creek and others may exist. In several areas the Edwards Limestone outcrop is very narrow and very thin (if it is present at all). These areas may provide barriers to dispersal and this karst fauna region is subdivided into four subregions: Northeast Fort Hood, Rocket River Cave, Egypt Hollow, and West Fort Hood.

<u>Northeast Fort Hood Subregion</u>**.** This subregion is defined as the outcrop of the Edwards Limestone north of Cow House Creek and extending west from Lake Belton to East Range Road. Where East Range Road crosses the outcrop, the Edwards Limestone has been removed. Although essentially all of this subregion is mapped as Edwards Limestone, several unmapped outcrops of the Georgetown Limestone have been observed and it may prove feasible to further divide this subregion. Seven species are endemic to this subregion: the spiders *Cicurina* (*Cicurella*) *caliga*, *Cicurina* (*Cicurella*) *hoodensis*, *Cicurina* (*Cicurella*) *mixmaster*, and *Neoleptoneta paraconcinna* and the ant-like litter beetles *Batrisodes* (*Babnormodes*) n. sp., *Batrisodes* (*Babnormodes*) *feminiclypeus*, and *Batrisodes* (*Babnormodes*) *gravesi*.

<u>Rocket River Cave Subregion</u>. This subregion is defined as the outcrop of the Edwards Limestone west of East Range Road and extending west to an extreme narrowing of the outcrop immediately south of Hubbard Cemetery. It is characterized by extreme subsurface drainage into the Rocket River Cave System and other probably related caves. No species is endemic to this region, and it appears to be a transition between the Egypt Hollow Subregion to the west and the Northeast Ford Hood Subregion to the east. It shares with the Northeast Fort Hood Subregion the spider *Cicurina* (*Cicurella*) *coryelli*, the millipede *Speodesmus castellanus*, and the ground beetle *Rhadine reyesi*. It shares with the Egypt Hollow Subregion the ant-like litter beetle *Batrisodes* (*Babnormodes*) *wartoni* and the spider *Cicurina* (*Cicurella*) *coryelli*.

<u>Egypt Hollow Subregion</u>. This subregion is defined as the outcrop of the Edwards Limestone west of the narrowing of the outcrop south of Hubbard Cemetery west to a narrowing

of the outcrop about 1 mile west of West Range Road. The area is poorly studied because of difficulty of access and additional species will almost certainly be found here. No species are endemic to the region and it shares three species with other regions. The spider *Cicurina* (*Cicurella*) *coryelli* also occurs in the Rocket River Cave Subregion and the Northeast Fort Hood Subregion. The ant-like litter beetle *Batrisodes* (*Babnormodes*) *wartoni* also occurs in the Rocket River Cave Subregion. The pseudoscorpion *Tartarocreagris hoodensis* also occurs in the Northeast Fort Hood Subregion.

West Fort Hood Subregion. This subregion is defined as the outcrop of the Edwards Limestone west of the narrowing of the outcrop 1 mile west of West Range Road and extends west to the boundary of Fort Hood. None of the species of concern are known to occur in this area, but it is expected that some will be found with further study.

Range of Species of Concern

Figures 1-7 show the ranges of the species of concern as numbered and presented in Table 2. Continued research will likely reveal additional localities of the species, but our interpretation of the biological and hydrogeological data thus far indicates that nearly all of those localities will be in caves within the bounds of the karst fauna regions and subregions as described for each species below.

Species 1 – *Cicurina* (*Cicurella*) *caliga*: This spider is only known from three caves in the Northeast Fort Hood Subregion of the North Fort Hood Region. As web-spinners, troglobitic spiders of this genus do not travel far within their lifetimes, staying close to or within their webs. All indications are that individuals of this species seldom roam far from the place of birth. It is likely that they reside primarily in caves rather than small interstitial spaces. Two of the caves, Streak Cave and Triple J Cave, are located within 500 m of each other while the third, Buchanan Cave, is about 5 km to the southwest.

Species 2 – *Cicurina* (*Cicurella*) *coryelli*: This spider is known from Egypt Cave in the Egypt Hollow Subregion, Tippit Cave in the Rocket River Cave Subregion, and Big Red Cave in the Northeast Fort Hood Subregion. As web-spinners, troglobitic spiders of this genus do not travel far within their lifetimes, staying close to or within their webs. All indications are that individuals of this species seldom roam far from the place of birth. It is likely that they reside primarily in caves rather than small interstitial spaces. This wide distribution indicates that this may be a more recent troglobite than other species.

Species 3 – *Cicurina* (*Cicurella*) *hoodensis*. This spider is known only from six caves in the Northeast Fort Hood Subregion. As web-spinners, troglobitic spiders of this genus do not travel far within their lifetimes, staying close to or within their webs. All indications are that individuals of this species seldom roam far from the place of birth. It is likely that they reside primarily in caves rather than small interstitial spaces.

Species 4 – *Cicurina* (*Cicurella*) *mixmaster*. This spider is known only from Mixmaster Cave in the Northeast Fort Hood Subregion. As web-spinners, troglobitic spiders of this genus do not travel far within their lifetimes, staying close to or within their webs. All indications are that individuals of this species seldom roam far from the place of birth. It is likely that they reside primarily in caves rather than small interstitial spaces.

Species 5 - *Cicurina* (*Cicurella*) *troglobia*. This spider is known only from Seven Mile Mountain Cave in the Seven Mile Mountain Region. As web-spinners, troglobitic spiders of this genus do not travel far within their lifetimes, staying close to or within their webs. All indications are that individuals of this species seldom roam far from the place of birth. It is likely that they reside primarily in caves rather than small interstitial spaces.

Species 6 – *Neoleptoneta paraconcinna*: This species is known only from three caves in the Northeast Fort Hood Subregion. All are located within 300 m of each other. As web-spinners, troglobitic spiders of this genus do not travel far within their lifetimes, having to stay close to or within their webs, although troglobitic *Neoleptoneta* seem more mobile and less speciated than troglobitic *Cicurina*. Possibly this mobility is due to their much smaller size, which would permit them to travel through much smaller interstitial spaces.

Species 7 – *Tartarocreagris hoodensis*: This species of pseudoscorpion is known from Chigiouxs' Cave in the Egypt Hollow Subregion and Buchanan Cave and Rugger's Rift Cave in the Northeast Fort Hood Subregion. It may also occur in West Corral Cave No. 4, but final determination requires further study. It will probably be found in the Rocket River Cave Subregion as well. Pseudoscorpions are extremely rare and only one specimen is known from each cave.

Species 8 – *Speodesmus castellanus*. This species of millipede is known definitely only from caves in the Rocket River Subregion and the Northeast Fort Hood Subregion. Specimens that cannot be determined have been found in the Egypt Hollow Subregion and may be this species. This species of millipede is extremely small and is obviously a recent troglobite. The wide distribution probably reflects its recent isolation in caves.

Species 9 – *Texoreddellia* new species. This species of silverfish is known definitely only from Seven Mile Mountain Cave in the Seven Mile Mountain Karst Fauna Region. A female from Nolan Creek Cave in the North Nolan Creek Karst Fauna Region may be conspecific, but males are needed for positive identification. It is unlikely that this species will be found outside of these regions. Extensive collections in other areas have not produced the species and this may represent the northern limit of distribution for the genus.

Species 10 – *Rhadine reyesi*: This beetle has been found in eight caves in the Northeast Fort Hood Subregion and one in the Rocket River Cave Subregion. Beetles of this genus are active predators and range widely in search of food. The recent gap in the limestone between these two subregions has probably not been long to allow speciation to occur.

Species 11 – *Batrisodes* (*Babnormodes*) new species. This beetle has only been found in Talking Crows Cave in the extreme northeast corner of the Northeast Fort Hood Subregion. It is separated from the nearest other species of the genus, *B. gravesi*, by only about 350 meters. The new species, however, was found in twilight below the entrance, whereas *B. gravesi*, lives on red clay in zones of total darkness. This new species, therefore, may be a more recent troglobite that lives in a different ecological zone than *B. gravesi*.

Species 12 – *Batrisodes* (*Babnormodes*) *feminiclypeus*. This beetle has only been found in Skeeter Cave in the Northeast Fort Hood Subregion. It occurs only about 1 km south of the nearest known locality for *B. gravesi*. As with the above species, however, this species has also been found in twilight and is probably a recent troglobite.

Species 13 – *Batrisodes* (*Babnormodes*) *gravesi*. This beetle has been found in ten caves in the Northeast Fort Hood Subregion. It is usually taken on red clay and appears to be an older troglobite than the two preceding species.

Species 14 – *Batrisodes* (*Babnormodes*) *wartoni*. This beetle has been found in two caves in the Rocket River Cave Subregion and one in the Egypt Hollow Subregion. Its distribution to the east appears to be restricted by the gap in the Edwards Limestone where East Range Road crosses the outcrop.

Species 15 – *Plethodon* new species. This salamander is known with certainty only from caves immediately south of Owl Creek and Bear Creek in the northern part of the Northeast Fort Hood Subregion. A sight record of a salamander from the Rocket River Cave System in the Rocket River Cave Subregion probably is this species. Regardless, it is of considerable interest that the species has not been found in caves in the more southern part of this subregion. It is clearly not a cave restricted species and it has been found on the surface at Bexar Springs. Further study is needed to determine its exact range. No salamanders of this genus have been found in caves in northern Williamson County and this may reflect the true range of the species.

Habitat, Ecosystem, and Ecology

Information on the life history, ecology, and habitat requirements for karst fauna is scant. Elliott (1994a) summarized three years of baseline ecological monitoring of endangered species in Williamson County, Texas, which are related to some of the species of concern at Camp Bullis. Reddell (2000) summarized five years of baseline ecological monitoring of endangered species on Sun City-Texas in Williamson County. Ellliott applied the same methodology, from October 1995 through April 1998, to ecologically monitor four Camp Bullis caves containing species of concern (Veni et al., 1996, 1998a, 1998b). Most research on cave fauna has focused on taxonomy, and on species distribution and behavior. Investigations of this type, as related to the species of concern at Fort Hood, include Chandler (2001), Cokendolpher and Reddell (2001), Gertsch (1992), Muchmore (2001), and Reddell and Cokendolpher (2001). Some research has examined the relationship between species and habitat distribution with hydrogeologic processes, and for the Camp Bullis area includes Veni (1996, 1997a, 1997b), Veni and Associates (1994), Veni and Elliott (1994), and Veni et al. (1995, 1996, 1998a, 1998b, 1999). No studies of this nature have been conducted on Fort Hood.

Origin of Caves and Karst Features

Karst is a terrain formed predominantly by the dissolution of the bedrock. It is usually characterized by features such as sinkholes, sinking streams, little or no surface water, underground streams, and caves. Most karst, including all that occurs at Fort Hood, is in limestone.

Karst landscapes generally start to develop once limestone is exposed to the surface. A typical limestone cave begins to form where water enters the rock along a fracture or bedding plane, and slowly flows downward until discharged at a lower elevation from a spring. Water that enters the ground is charged with carbon dioxide from the atmosphere and soil to create a weak carbonate acid. Over millennia, this weak acid slowly enlarges fractures and bedding planes. As the openings become larger, they drain water more efficiently, and thus can drain larger volumes of water, which enlarge the openings at faster rates. This process self-accelerates until one flow path toward the spring comes to dominate the local drainage pattern and captures flows from smaller channels. When it becomes large enough for human exploration, that conduit is called a cave.

In the ideal situation, drainage flow paths through a karst aquifer look like a branching surface stream. The tips of the hydrologic network typically include fractures, sinkholes, and sinking streams that capture surface water and route it underground. In the subsurface, each branch flows downstream to join other branches, eventually forming limbs and then the trunk of the underground drainage network which discharges from a spring. These larger branches of the karst aquifer are frequently caves. However, geologic and hydrologic factors sometimes prevent the development of such ideal flow systems. The type and degree of karst aquifer development, and the extent of human access into caves, is determined by fractures and folds in the rocks, the types of rock encountered, surface and groundwater hydrologic regimes, collapse of caves passages, sediment and speleothem deposition in conduits, and changes over time and distance with each of these factors.

Caves are integral parts of karst aquifers because of their great ability to transmit water, which make them the focus for groundwater convergence for poor to highly permeable flow paths. In the Fort Hood area, many caves formed during previous hydrologic regimes are largely unrelated to the modern aquifers that are primarily recharged by younger caves. However, even these older caves, by virtue of being highly permeable features, capture locally available water from the surface to form recharging drips, pools, and streams. Some eventually capture sufficient water to be rejuvenated as significant, hydrologically active recharge sites. Whether a cave captures large or small volumes of water, the rate, volume, and quality of water that flows through it, and the materials carried in the water, directly reflect the conditions and activities on the surface in the cave's drainage basin.

The ability of karst aquifers to rapidly recharge large volumes of water through caves, and even via much smaller conduits, and transmit those waters with effectively no filtration, makes karst aquifers the most sensitive to groundwater contamination. Studies repeatedly show that when significant volumes of contaminants are present in karst areas, they significantly impact the water quality of the underlying karst aquifers. This close hydrologic connection with the surface also makes karst aquifers sensitive to physical changes in the landscape. Increased flooding, decreased runoff, sedimentation, and erosion on the surface are often mirrored by changes in caves and the general behavior of the karst aquifer. Effective engineering solutions to prevent many of the problems that are unique to karst are few and still developing, so it is important that activities in karst areas avoid creating problems in the first place. For comprehensive overviews of cave and karst hydrogeology, see White (1988) and Ford and Williams (1989).

Evolution of Troglobites

Troglobites are generally believed to have developed as a result of climatic changes in the Pleistocene epoch (two million to ten thousand years ago). This resulted in the extinction (at least locally) of surface populations, whereas those species inhabiting caves as troglophiles became genetically isolated. In some cases, the surface ancestor no longer inhabits the surface; in other cases, the surface ancestor may have re-invaded the area when climate changes occurred but have become genetically isolated from the cavernicole populations (Barr, 1968; Mitchell and Reddell, 1971; Elliott and Reddell (1989). Where a single species occupied caves over a broad area, canyon down cutting and faulting led to isolation of different populations and subsequent speciation. This, in some respects, resembles the concept of speciation in islands in that a single ancestor may have given rise to species in isolated "islands" of karst. The occurrence on Fort Hood of several species of *Cicurina* and *Batrisodes* is a good example of this type of speciation. One genus on Fort Hood belongs to a tropical group no longer found in the Texas fauna. This genus, *Texoreddellia*, has its closest relatives in Mexico.

Habitat Requirements

<u>Moisture and Temperature</u>

Troglobites require high humidity, although some species are more dependent on higher humidity than others. Delicate, highly evolved troglobites such as *Speodesmus* millipedes, some spiders, *Texoreddellia* silverfish, and some *Batrisodes* and *Rhadine* beetles are usually found only in the deepest parts of caves where humidity is essentially 100%. Less cave-adapted species of *Cicurina* spiders, *Cambala speobia*, and the less cave-adapted *Batrisodes* may be found closer to the entrance where humidity may be significantly lower. Dry caves or dry parts of caves are typically devoid of cave fauna, and troglobites are essentially absent. Under unusually wet conditions troglobites may venture closer to entrances where food is more abundant, but can be expected to retreat deep into crevices or the soil when drying occurs.

Most troglobites require stable temperatures. When cold air settles into a cave, some species normally found roaming on cave floors might retreat to ceiling pockets where the air temperature is higher. Other species will move into the soil, loose rocks, or interstitial spaces during hot, dry conditions.

<u>Importance of Surface Communities</u>

The absence of green plants in caves means that the nutrient for cave fauna must enter from the outside. "Karst ecosystems receive nutrients from the surface in the form of leaf litter and other organic debris that have washed or fallen into the caves, from tree and other vascular plant roots, or through the feces, eggs, or dead bodies of troglophiles and trogloxenes (for example, cave crickets, raccoons)" (USFWS, 1994).

Floodwaters may bring surface species far into caves, but on Fort Hood, the most biologically diverse caves with respect to troglobites do not suffer significant flooding. Although numerous species may be found in leaf litter, soil, and cave ceilings and walls just inside the entrance of caves that do not flood, low humidity and fluctuating temperatures prevent these species from serving as a food source for the more cave-adapted troglobites. The most significant invertebrate species to the cave ecosystem in Texas are cave crickets of the genus *Ceuthophilus*. These species may be found in all parts of caves, although they tend to be most abundant near cave entrances. Two species inhabit caves on Fort Hood. One of these, *Ceuthophilus* (*Geotettix*) *cunicularis* Hubbell, is a floor-dwelling troglophile that rarely leaves the caves. They can be observed in the caves at all times of the year. The other species, *C.* (*C.*) *secretus* Scudder, roosts on the ceiling and leave the caves at night to forage for food. Some species of *Rhadine* beetle in Travis and Williamson Counties are specialized predators of cave cricket eggs laid in pulverulite (Mitchell, 1971b). *Rhadine* on Fort Hood have been observed feeding on cave cricket eggs but are usually found on red clay. *Tartarocreagris* and *Cicurina* have both been observed to feed on cricket nymphs. Dead crickets have been observed being eaten by *Rhadine*. Cave cricket droppings develop fungal growth that provides food for springtails (Collembola) and millipedes, which are probably a significant prey of small troglobitic predators.

Bats introduce a significant amount of nutrient input into many caves in the form of guano. Large deposits of guano, however, are not suitable habitat for most troglobites for several reasons. Temperature and pH fluctuations are severe in guano deposits and thus are unsuitable for species evolved for a narrow range of environmental parameters. Guano also harbors large numbers of predators, such as mites and beetles, which may also feed on the cave-adapted fauna. Small deposits of guano, especially of *Myotis velifer*, may be beneficial to the overall cave ecosystem in that it provides an additional food source. While the troglobites may not inhabit the main guano deposits, they may be found in adjacent areas. The absence of endemic troglobites in one of the larger caves on Fort Hood, Shell Mountain Bat Cave, to a large extent may be result of the large population of *Myotis velifer* inhabiting the cave.

The only other vertebrate of any great significance to cave fauna on Fort Hood is the raccoon, *Procyon lotor*. This species may venture deep into caves where its droppings rapidly develop a thick coating of fungus that supports large springtail colonies. The droppings may also be colonized by fly and beetle larvae, which may serve as prey for specialized troglobitic predators. Heavy use of caves by raccoons, however, may be detrimental because of the large amount of feces deposited and subsequent increase in non-troglobitic predators.

The maintenance of healthy plant communities on the surface above and in the vicinity of caves is essential to the maintenance of healthy cave ecosystems. Plants provide food for foraging cave crickets, reduce the amount of run-off into caves, and buffer the caves from extreme changes in temperature and humidity. A natural plant community also reduces the number of exotic species (particularly fire ants) that may adversely impact cave ecosystems. Excessive growth of Ashe juniper, however, may be detrimental to cave ecosystems by reducing the amount of available moisture and diversity of soil and litter faunas.

Use of Interstitial Spaces

The interstitial zone is the area of small, humanly impassable, solutionally enlarged voids that provide potential habitat for cave-dwelling species in the areas between caves. The zone generally extends from caves in the form of micro-conduits that contribute some of the water that forms the caves. Types of interstitial areas include solutionally widened bedding planes and fractures, anastomosed bedding planes and fractures, honeycomb solution zones, non-cemented collapse or fault-brecciated areas, and porous cave sediments. The interstitial zone also includes caves that have been near-completely filled with sediment.

Much of the interstitial zone is characterized by what White (1969) described as the diffuse flow component of karst aquifers. Its most intensive development occurs adjacent to horizontally extensive caves and where cavernous limestone crops out at the surface. The interstitial zone is laterally extensive near caves because caves are sites of flow-path convergence, and because groundwater is injected into interstitial openings when caves flood. The exposure of cavernous limestone at the surface allows for vertical interstitial development associated with epikarstic solution of fractures, which can interconnect with horizontal interstitial zones and horizontal caves. Below the water table, the interstitial zone is the extensive and permeable system that supplies most groundwater to wells.

Based on study and observation throughout the San Antonio region, the interstitial zone is generally vertically and laterally extensive (Veni and Associates, 1994). In some cases, interstitial zones may not hydrologically connect certain caves, but could provide avenues of movement between those caves for some cave-dwelling species.

The interstitial zone is critically important to cave ecosystems, not only for contributing water, but also for food. While many nutrients enter cave ecosystems through cave entrances and sinkholes, the interstitial zone provides most food energy to the deeper parts of caves (Howarth, 1983; Holsinger, 1988, Elliott and Reddell, 1989, USFWS, 1998). Most nutrients are carried as dissolved organic material or organic fragments; some are directly contributed where tree roots reach down into the interstitial zones and caves.

The biological bounds on karst fauna occupying and moving through the interstitial zone are determined by food availability. Adequate moisture is also vital to karst faunas but varies little through interstitial voids whereas food ranges from abundant to absent. The minimum width of interstitial voids, for a significant cavernicole fauna is probably 5-10 mm; this width corresponds to the threshold of turbulent groundwater flow that could carry particles of organic nutrients to cave species. Although some species can traverse smaller openings, the lack of food probably restricts their migration. Collins (1989) found fracture and bedding plane widths to be generally less than 1 mm in the Georgetown Limestone, which is not known to have a cavernicole fauna, while widths in the Edwards Limestone range from “a few millimeters to a few centimeters,” and does support a rich cavernicole population. Similar findings in Europe show cave fauna to generally inhabit voids greater than 1 mm in width (Juberthie and Delay, 1981). Yet even with sufficient space, an absence of sufficient nutrients will still result in an absent fauna. Veni and Associates (1992) described areas in the Austin, Texas, area where no significant karst fauna occurs due to poorly permeable strata at the surface that limits nutrient input to underlying caves. Occasionally, construction encounters caves that are completely lined with calcite crystals; nutrients do not enter these caves and karst species are not present. Similarly, fractures and other features sufficiently enlarged to contain fauna may lack karst species if they do not contain nutrients, as suggested by Sherrod’s (1991) research, where only one of four drilled boreholes that intersected voids yielded troglobites when baited. Furthermore, the one borehole that did contain troglobites was in an area of fractures and depressions that allowed nutrient input from the surface. A similar study by Reddell (unpublished) in northern Travis and southern Williamson Counties produced a troglobite in only one of seven boreholes, all of which contained cavities. The only borehole containing a troglobite was immediately adjacent to a large shallow sinkhole that drained down into a karst conduit. This indicates that nutrient input from the surface was entering the void intersected by the borehole.

Management Considerations

The evolution of karst invertebrates requires adaptation from surface processes where environmental conditions are often in constant and considerable flux, to conditions underground where environmental changes are small to nearly imperceptible, and usually gradual (Howarth, 1983; Holsinger, 1988). The sensitivity of some troglobite species to the narrow range of environmental conditions present in caves is illustrated by moderate to high numbers of laboratory mortalities due to small environmental changes during attempts to raise immature invertebrates to maturity (Veni et al., 1999).

Research in Texas caves to date suggests certain general requirements for the protection of cave ecosystems (Elliott, 1993a, 1994b; USFWS, 1994, 1998):

- **Maintain stable microclimatic conditions.** High and stable humidity is especially important as indicated by laboratory studies (Veni et al., 1999) and the retreat of fauna into moist zones during dry conditions (Elliott and Reddell, 1989).

- **Maintain an adequate water supply.** Water flowing into caves and their associated karst features is critical to maintaining the cave's humidity and carrying nutrients to their ecosystem. Artificially induced flooding may harm ecosystems by drowning species, altering the nutrient supply, and introducing harmful surface species.

- **Maintain an adequate nutrient supply.** In meeting this requirement, care should be given to prohibit excess nutrients from cave ecosystems that are adapted to food-poor conditions (Barr, 1968; Howarth, 1983). Caves that accept floodwaters, even if they do not completely flood, will receive greater inputs of organic material and generally have smaller and less troglobitically diverse populations than caves that accept few floodwaters.

- **Prevent contaminants from entering the ecosystem.** Contaminants are either carried or washed into caves. People entering caves should not leave materials behind. Trash, non-natural materials, and natural materials in unnatural quantities should not be dumped into caves or karst features. To prevent contaminants from washing into caves requires delineation of the caves' drainage area. Two types of areas drain into caves. The first drains directly into cave entrances or karst features that are clearly associated with the caves. The second drains into more distant fractures and karst features that are determined as hydrogeologically connected to the caves. Contaminants should be kept out of both drainage areas. If such prohibition is not possible, contaminants should be contained and kept to a minimum such that an accidental release would not significantly harm the ecosystem. Maintaining the drainage areas in their natural state provides appropriate nutrient input and prevents contamination.

- **Prevent or control exotic species.** Actions may be needed to eradicate or control non-native species that prey upon or compete with species native to the cave ecosystem. Any methods used should first be carefully considered for their potential adverse impact on the cave ecosystem, which would also likely be sensitive to those actions.

- **Prevent unregulated disturbance of the ecosystem.** Excessive and uncontrolled visitation of caves may unintentionally harm their ecosystems though trampling, compaction of sediments, and introduction of potentially harmful materials, such as batteries (Reddell, 1993). Properly regulated access to caves can prove beneficial by monitoring the ecosystems, removing potentially harmful materials carried or washed in, and restoring areas to their natural conditions when needed (Reddell et al., 1999).

- **Coordinate cave management with other resource management needs.** Management of additional resources may affect the management of cave ecosystems. Examples on Fort Hood include endangered bird species, rangeland vegetation restoration, and archeological sites. Some needs may conflict. Each will require coordination according to the appropriate regulatory requirements, and for the most benefit with the least harm.

Ecology

Species 1, 2, 3, 4, and 5– *Cicurina* (*Cicurella*) *caliga*, *C.* (*C*) *coryelli*, *C.* (C.) *hoodensis*, *C.* (*C*) *mixmaster*, and *Cicurina* (*Cicurella*) *troglobia*. Cicurinas in caves live solitary lives in webs constructed under and among rocks. Troglobitic *Cicurina* spiders are not found in wet situations but cannot tolerate very dry conditions either. They are able to tolerate a wide range of temperatures but cannot survive long in low humidity. Areas of caves occupied by eyed cicurinas, generally near but not in cave entrances, also are home to many types of invertebrates. Some eyed, non-troglobitic species will be discussed below as possible models of blind cicurinas where information and observations for the troglobites are lacking.

In some caves, larger spiders (lycosids and ctenids) and centipedes are present in the entrance areas. Although immatures of these other species could serve as prey for eyed cicurinas, adults of these species would almost certainly eat even adult cicurinas. The numerous isopods, crickets, beetles, and harvestmen found near cave entrances could serve as prey for cicurinas and probably would not harm them except possibly if they were detected while molting. Dead *Rhadine* beetles have been found in *Cicurina* webs. A blind *Cicurina* has been seen carrying a *Speodesmus* millipede. Some *Ceuthophilus* crickets also occur in the parts of caves where troglobitic cicurinas occur. Cricket nymphs, as well as a few other cavernicolous invertebrates such as *Texoreddellia* silverfish, and *Pseudosinella* springtails, probably occur in the diet of blind cicurinas. *Cicurina* are active predators and will eat each other as well as almost anything which might come close to their web retreat. In captivity, they will eat almost any smaller living arthropod; even hard-bodied beetles, wasps, and isopods are accepted.

Cicurinas bite prey with their fangs and hold them tight with the chelicerae. They do not release the prey and allow the venom to act, as do some other spiders. The venom of cicurinas is very potent, as preys have been observed to struggle only for a moment. Likewise, observations of larger cicurinas preying on smaller specimens of the same species reveal little struggle following the bite. These observations suggest the evolution of more potent venom because of food scarcity, but precise toxicological data are not available.

The web of the troglophile *Cicurina varians* in captivity is a tube that opens into a small sheet. The tube can be forked or multi-branched, depending on the substrate. Large specimens of *C. varians* in captivity will fill a jar with webbing. Both adult males and females will build new webs if their old webs are destroyed. The tube diameter is about the distance of the legs held partially extended, or about ¾ the width of the body. In captivity, the diameter of the web changes as the animal grows, as the web is altered to fit the individual. It is unknown if this happens in the cave, or if the growing animal abandons its web and builds a new one. Abandoned webs are sometimes found in caves, possibly also due to predation. In captivity, the web can also be a simple tube around the base of the wall of the jar. In such cases, the webbing will be attached to the floor and on the adjacent wall of the jar. The webbing is rounded above and the glass beneath the web will not be coated with silk. Several blind specimens had well developed webs, and in one web a distinct tube could also be detected. Generally, the troglobitic species have delicate webs of only a few strands or maybe a loose flat sheet. A few individuals in captivity never constructed webs, but they were able to catch food and develop. *Cicurina varians* generally hang upside down in the tube area. Unlike agelenid spiders, they do not always sit at the edge of the tube facing out on the sheet. This may be because they have more than one "sheet" web (at least one on each end of the tube, more if a branched tube). The smaller troglobitic forms generally sit on the substrate under the "sheet" or the few strands of webbing. Larger spiders will often hang upside-down on the web. Although it would be interesting to suggest that the troglobitic species have reduced or given up web building because their prey are scarce and that they have to go in search of it, this could be entirely wrong. Because we do not know the ancestor(s) of the troglobitic forms, we cannot assume that they built webs like *C. varians*. Possibly the ancestor(s) of the troglobites also did not use webs as much. On the other hand, it might be advantageous in a rare food environment to sit and wait for such prey because less energy is expended in making a web than in walking around the cave searching for food.

Bennett (1985) reported that epigean *Cicurina bryantae* Exline from the eastern U.S.A. probably has a life span of two or more years; the immatures take more than a year to mature. His studies suggest some females may be able to produce offspring for two seasons, thus over-wintering as an adult to mate the third year as an adult. *Cicurina varians* can reach sexual maturity in one year in captivity, but the same is not true for troglobitic *Cicurina*. Several small immatures of troglobitic species recently collected and maintained in captivity molted once after six months, suggesting that it might take a much longer period than a year to mature. Larger immatures and adults can go weeks to months without feeding in captivity. One half-grown (determined from size) *Cicurina* sp. (probably *madla*) from Headquarters Cave on Camp Bullis remained in captivity occasionally feeding for over 11 months before molting once. Not all troglobitic cicurinas grow as slowly. An immature collected in MARS Pit on Camp Bullis on 9 September 1998 molted on 24 September 1998, 19 December 1998, and 23 January 1999. It died while apparently trying to molt again on 20 March 1999 (Veni et al, 1999). Five other immatures from the same cave each molted only once or twice during this same interval, but they are all still living as of September 1999. The single known adult of *Cicurina* (*Cicurella*) *troglobia* from Seven Mile Mountain Cave was originally collected as a large immature on 28 June 2000 but did not mature until 14 July 2001. An immature collected on 28 June 2000 was still alive on 21 February 2002 without having matured, indicting that it may take up to (or more than) two years for maturity to occur. Possibly rapid growth is not advantageous, even when available food would support such activity. In captivity, attempted matings of *C. varians* can be hazardous since one of the sexes (generally the smaller) will often be eaten. Only one attempt of mating a troglobitic *Cicurina* has been undertaken and the male was quickly killed. In this case, it is uncertain if the female was just hungry or did not want to mate. Since males are so rare, it was removed and preserved before it could be determined if the female would eat it. This is possibly why adult males are seldom encountered in caves. They may serve as a source of sperm as well as a protein source for the production of the eggs.

The eggs of *Cicurina* spp. are laid in a small silken sac that is covered with bits of earth or attached to the inner wall of the retreat, where it remains with the female. *Cicurina varians* egg sacs are placed within the web next to the substrate. An egg sac of a troglobitic species has not been observed.

Predators larger than cicurinas, such as other spider species, are not present in the darker regions of the cave where troglobitic cicurinas occur. An immature *Cicurina* sp. was found dead in Bunny Hole on Camp Bullis on 9 September 1998. A pathogenic fungus had killed it. No other parasites or pathogens have been discovered.

Species 6 – *Neoleptoneta paraconcinna*.: This species (based on observations of specimens from Peep in the Deep Cave) is found in webs it spins in and under rocks in the dark in relatively moist, but not wet situations. Because the spider is very tiny, it quickly becomes entrapped by and can drown in droplets of water. It is not found in areas of active water dripping. Although the spiders spend much of their time in the web, they are also seen walking on the substrate near the web. Preliminary studies of captive specimens reveal that *Neoleptoneta* females lay a single large egg per egg-sac. The egg-sac is placed in the web and hatches within a month. The female may lay two or three eggs over a period of a few weeks. The egg sacs are white and camouflaged with whatever debris the female can find in or around the web. Covering the egg-sacs with debris is probably a carry-over from when this spider's ancestors lived in environments where predators could see, since camouflage probably serves little function in the dark of a cave under a rock. The spiderlings are white in color and large. Their growth is relatively rapid, and they reach adulthood in about six months. The spiders do not appear to be cannibalistic when adequate food is available. In captivity, mothers and young can be found living in the same webs. In captivity, this spider can be reared to adulthood entirely on small live collembola and non-predatory mites. This spider can tolerate relatively wide fluctuations in temperature, but will desiccate quickly in drier environments.

Species 7 – *Tartarocreagris hoodensis*: No observations have made on the feeding behavior of this species, but other species of *Tartarocreagris* have been observed eating young nymphs of cave crickets (*Ceuthophilus*). One species was observed obviously tracking a millipede of the genus *Speodesmus* but disappeared into a hole before further observations could be made. This species has been collected from the undersides of rocks in moderately dry sections of caves. Nothing else is known about its ecology.

Species 8 – *Speodesmus castellanus.* No observations have been made on the feeding behavior of this species, but it probably feeds on fungus spores or rotting organic matter. More highly cave-adapted species of the genus usually are found on wet flowstone or cave walls. The species from Fort Hood is a small, less cave-adapted species and has been taken on silt-covered walls in Rocket River Cave and from loosely compacted, organically rich soil in Keyhole Cave. Females build a small earthen chamber in which they lay their eggs. The young then stay in this for some time before emerging. Similar chambers may also be constructed for protection during molting. Numerous chambers were found on mud banks along cave walls in Rocket River Cave.

Species 9 – *Texoreddellia* new species: This species roams widely over cave floors and walls. In other areas it is usually found in total darkness, but on occasion has been taken nearer entrances in newly opened caves. The species probably feeds on fungus spores and possibly other decaying organic matter. The species from Fort Hood is less cave-adapted than species of the genus from the southern part of its range and may have a wider tolerance for temperature and humidity fluctuations.

Species 10 – *Rhadine reyesi*: This species has primarily been found on red clay and on cave walls in darkness. Nothing else is known of its habits. As in other species of the genus, it is probably an opportunistic feeder. Mitchell (1971a, 1971b, 1971c) has studied the dispersion, feeding habits, and temperature and humidity preferences of *Rhadine subterranea*. The data for this highly specialized cave cricket egg predator may not be applicable to other species. Numerous observations indicated that the species avoids cave cricket nymphs and staphylinid beetles, indicating that it is not an active predator. It would readily feed on injured and dead cave crickets. It has never been found in direct association with raccoon or other mammal feces.

Species 11, 12, 13, and 14 –*Batrisodes* (*Babnormodes*) new species, *B.* (*B.*) *feminiclypeus*, *B.* (*B.*) *gravesi*. and *B.* (*B.*) *wartoni*: Pselaphine beetles are generalized predators of small invertebrates. *Batrisodes* (*Excavodes*) *globosus* (LeConte), a surface species that has been taken in Texas caves, has been observed feeding on earthworms and will apparently feed on anything small enough to capture (Park, 1964). There are no observations on the feeding behavior of the troglobitic species, but they presumably feed on springtails, mites, and other minute arthropods. Of the four species from Fort Hood, the two more cave-adapted species, *B. gravesi* and *B. wartoni*, have been found on the underside of rocks and clay balls buried in red clay in total darkness. The two other species are less highly cave-adapted and have been taken from the underside of rocks on red clay and silt at the bottom of cave entrance drops.

Species 15 – *Plethodon* new species: This species is most commonly found in leaf litter below entrance drops, but is occasionally seen in the dark zone on ledges and cave walls. *Plethodon* salamanders are susceptible to desiccation and retreat deep into breakdown or back into crevices when cave moisture is low. They doubtless feed on invertebrates living in the litter or on cave walls and ceilings. One specimen in Coyote Den Cave was found still alive but hopelessly tangled in a large web of the spider *Tidarren sisyphoides* on the cave ceiling.

Current Threats

Several threats to the species of concern exist on Fort Hood. Most threats to cavernicole species are related to urban growth into karst regions where species of limited distribution are present. Individually and collectively, the threats result in the loss of habitat for the species as well as impacting the species directly. Generally, these threats or their potential are present in lesser degrees at Fort Hood than in urbanizing areas (see Conservation Measures section). The following discussion addresses threats to the proposed species as identified by USFWS (1998). However, since the non-proposed invertebrate species of concern occupy similar habitats, have similar ecological needs, and are harmed by similar factors, the threats are assumed to apply to all species of concern.

The habitat and other requirements of the salamander species are similar in several respects to the invertebrate species, but some significant differences occur. The discussion of threats will include the salamanders unless otherwise stated, in which case exceptions and additional factors relevant to the salamanders will be presented.

Present or Threatened Destruction, Modification, or Curtailment of Habitat

Discovery and destruction of caves has historically occurred and increased in many areas as the degree of urban growth onto the karst has increased. Veni (1988) documented 45 of 208 caves then known in Bexar County as sealed or destroyed, and nine caves that were used as trash dumps. Since that time, the number of caves known, caves sealed or destroyed, and trash-filled caves have approximately doubled (Texas Speleological Survey, unpublished data, 1999). While the number of caves reported at a given time is artificial, simply representing those known and not how many really exists, the number of sealed or destroyed caves is not artificial. Of the 88 sealed or destroyed caves, the fauna of 75 had not been biologically studied, and species proposed for endangered listing were present in five and possibly six caves. Three of the caves with proposed species were only loosely sealed and later reopened, at which time the proposed species were found. At least one cave on Fort Hood was reportedly deliberately sealed by the military. It is likely that others have also been deliberately filled

One impact on Fort Hood caves has resulted from ranchers who owned the land prior to its purchase by the federal government. At least two caves were used as a domestic trash dump: Big Red Cave and Mixmaster Cave. Since the trash fill was removed, species of concern have been found in each.

While Fort Hood no longer purposefully seals or destroys caves, other activities and circumstances are potentially harmful to the habitat of the species of concern. These can be generally grouped in their probable order of descending impact as: construction, soil erosion, water quality, and training activities.

Construction

Construction of buildings and other training facilities on Fort Hood are thus far limited to the cantonment area and other lowland areas. No facilities have yet been built in karst areas, but this could easily change in the future. Such construction, as in urban areas, may result in the actual destruction of caves and in serious adverse impacts by pollution.

Soil Erosion

Some caves on Fort Hood appear impacted by historic elevated rates of soil erosion. The

Fort Hood and Edwards Plateau region have experienced sustained soil erosion over the past 10,000 years, including an accelerated period during the last 200 years following European settlement and intensive use of the land (Toomey, Blum, and Velastro, 1993). Thick soil deposits in some Fort Hood caves appear to reflect continued soil erosion in their drainage areas.

Fifteen caves on Fort Hood containing species of concern were blocked by black topsoil. Many additional sinks currently filled with sediment are likely habitat for troglobitic species. It is likely that thick black sediment deposits in many caves are a result of soil erosion related to livestock grazing.

Soil erosion has three primary detrimental effects on cave fauna. First, it alters the food chain in caves. Highly evolved troglobites, such as the species of concern, are adapted to food-poor conditions. The higher food energy levels associated with soil erosion supports the introduction of organisms that can more successfully compete for food and may potentially be predatory on the species of concern. Second, soil erosion changes habitat conditions in caves. Cave crickets often lay eggs in silty sediments, which are found and eaten by the rare *Rhadine* beetles. Eroded soils that are deposited in caves often bury those silty sediments under dense clays and organic debris. These clays also tend to plug caves so they drain less efficiently, resulting in periodic and more intensive flooding, and intervening periods of greater moisture and ponded water. Third, soil erosion can eliminate habitat by completely or near completely filling caves.

Water Quality

Karst areas are known as being the most vulnerable to contamination due to the ease and speed at which contaminants enter and travel through their aquifers, usually with effectively no filtration. While most karst water quality research focuses on contaminants transport through large features like caves and sinkholes, several studies have shown that water movement through the diffuse flow portion of karst aquifers also does not filter contaminants or prevent their movement underground. Friederich, Smart, and Hobbs (1982) found soil bacteria moving into a British karst aquifer via diffuse flow waters dripping into a cave. Veni (1997) examined similar drip waters in a Texas cave and found a chemical signature indicative of septic effluent. Ogden et al. (1991) concluded conduit development is of secondary importance to the type of land use in a karst aquifer's recharge area due to high non-conduit permeabilities; if contaminants are present, they will almost certainly reach the aquifer. Successful pollution prevention in karst areas is best achieved by protecting the most vulnerable areas from pollutants, maintaining their drainage basins in their natural state, and minimizing pollutant loading of the aquifer (Veni, in press).

Toxicological studies have not been conducted on the effects of water-borne contaminants on the species of concern or closely related species. However, the adverse impacts of a wide array of organic chemicals, heavy metals, and other contaminants on many different organisms suggest probable harmful effects on the karst species. The most likely means of transporting contaminants into caves is in recharging waters. Contaminant sources on Fort Hood can be divided into two groups: point and non-point.

Point sources release contaminants from specific locations. Leaks and spills associated with sewage transmission lines to sewage treatment facilities could adversely impact the species of concern through excessive nutrients, and possibly through bacterial or chemical harm. No such impacts are known on Fort Hood, and their potential for occurrence is low because the sewage facility and transmission lines are limited to the Cantonment Area where karst features are not known.

Traffic accidents or vehicle malfunctions along roadways may result in point source spills of gasoline, diesel, or other harmful chemicals onto the ground, and in sufficient volume where they might flow into a cave or karst feature with species of concern. The potential is increased if the spill occurs during a storm, or if an emergency response crew hoses away contaminants rather than containing and removing them. No paved roads occur in the vicinity of caves on Fort Hood, but many heavily tank trails cross over or are very near to caves. Numerous caves are located within a few meters of unpaved roads and Camp 6 Cave No. 1 extends under an unpaved road. Fueling of vehicles has been observed upslope of the entrance to Mixmaster Cave and may actually occasionally occur above the cave.

No landfills occur in karst areas on Fort Hood.

Non-point source contaminants are derived from broad areas and no single feature or location. Typical non-point sources include bacteria and fertilizers associated with rural land use, and heavy metals and organic chemicals from runoff. Schueler (1994) found that drainage areas with less than 15-20% impervious cover generally suffer no significant adverse water quality or stream ecology impacts from non-point contaminants.

One atypical potential non-point contaminant source may be from present firearms training and firearms and artillery use. Contaminant releases should be slow, intermittent, low in volume, and scattered, due to the relatively small size of the ordnance over the broad area, and the different weathering rates based on the ordnance's specific location, type, and date of deposition. However, considering that heavy artillery use is conducted in large areas of Fort Hood that contain major karst features some water quality analyses of its runoff may be warranted. This is of special concern in the Rocket River Cave system and associated caves. All drainage in the area is underground and significant streams flow through these caves.

Training Activities

Military training at Fort Hood poses two types of threats to the species of concern not discussed above: deliberate sealing of caves, and trash. With multiple training and administrative programs at Fort Hood, including different branches of the military, there is potential that caves and karst features could be filled by well intentioned personnel who perceive the features as potential sources of injury. The chance for such actions is low among the known caves; features that are obviously hazardous and/or in high traffic areas are gated.

Military personnel who discover caves during training often dispose trash into the caves. For example, Lemonette Cave contained several feet of military debris. This was removed in 1996 but a return visit in 2002 found the lower passage once again blocked by debris. Several feet of military debris, including tank treads and various buckets containing undetermined materials covered a pre-existing domestic dump in Big Red Cave. Incidental trash has also been found in several other caves. Trash can upset the nutrient balance of a cave's ecosystem, increase the number of non-native predatory and competitive species, and introduce harmful contaminants to the ecosystem.

Numerous filled sinkholes have been found in firebreak lines on Fort Hood. Some of these appear to have once been open caves. Large rocks have been bulldozed into the cave entrances and increased soil erosion has further sealed the openings.

Intensive tank training activity in the vicinity of Brokeback Cave and Runoff Cave is probably largely responsible for intense erosion filling potential lower levels of the caves. Tanks regularly drive to within a few meters of the entrances to Shell Mountain Bat Cave.

Although no examples are known of cave entrances or passages being destroyed by artillery bombardment, this is a very real possibility in the impact zones.

Over-utilization for Commercial, Recreational, Scientific or Educational Purposes

None of the karst species on Fort Hood are utilized for commercial or recreational purposes. Many caves in Central Texas are used for recreational exploration, but such usage does not occur at Fort Hood. Scientific study of the species of concern often requires collection and preservation of a few individual specimens. These small numbers are not considered sufficient to harm the overall populations of the species (USFWS, 1998), and since all biological studies of karst species at Fort Hood have been coordinated under one set of researchers, the potential for inadvertent over-collection is virtually eliminated. Biological monitoring of caves at Camp Bullis and other areas in Central Texas showed no effects that were correlated to intervening mapping and geological study trips, which were comparable in impact to the training sessions (Veni et al., 1996, 1998a, 1998b).

Disease or Predation

Non-native fire ants pose a major threat to the survival of the species of concern. They are voracious predators that find the temperature and humidity of central Texas caves ideal for some of their needs. While successful fire ant mounds are not known in caves, except for a few in entrances with sufficient soil, fire ants have been observed to travel more than 100 m horizontally into caves and prey upon karst invertebrates (Elliott, 1992, 1993b; Reddell, 1993; Reddell and Cokendolpher, 2001a). In general, caves significantly invaded by fire ants have a substantially lower diversity of native karst species and number of individuals than typically observed in caves lacking fire ants. Likewise, the observed numbers and diversity of karst species in caves has been observed to decline following the entry of fire ants into their ecosystems. These observations are consistent with the findings of Vinson and Sorenson (1986) and Porter and Savignano (1990) that arthropod diversity drops in the presence of fire ants.

Land disturbance from construction areas, plus roadways, lawns, and other areas of human activities facilitate the dispersion of fire ants. While fire ants are present at Fort Hood, the installation's large area of undeveloped land may reduce or limit the presence of fire ants. Fire ants have been documented from 31 caves on Fort Hood, but fire ants will doubtless be found in many additional caves. Many collections were made in winter months when fire ants are not active. The greatest degrees of infestation have been found in caves near roads or areas of heavy training activity. Some caves, such as Buchanan Cave, Estes Cave, and Streak Cave that lie away from roads have not been observed infested.

Inadequacy of Existing Regulatory Mechanisms

No regulations exist that specifically address impact of activities on karst invertebrates. Strict regulations on activities impacting the Edwards Aquifer do not apply to Fort Hood. Consequently, regulatory authority for the protection of the species falls to the USFWS, but only after the species have been listed as threatened or endangered. Until then, protection and management of the species depends almost entirely on the landowner.

Other Natural or Man-made Factors

Currently, trespassing onto Fort Hood or its caves is not a significant problem. Although military personnel are forbidden to enter caves, this has not always been strictly enforced as evidenced by obvious entry into caves with larger entrances.

Conservation Measures

Several threats and potential threats to the karst species of concern were identified in the previous section. In this section, conservation actions taken by Fort Hood to date are described, including several to reverse, mitigate, or prevent the listed threats. While many of the threats are similar to those in karst areas of other areas, the threats or their potential are present in lesser degrees at Fort Hood due to four important differences:

1) construction is limited to non-karst areas;
2) self-imposed regulations limit the environmental impacts of military training and other activities;
3) research is regularly funded to define environmental resources and recommend appropriate management strategies; and
4) an Environmental Office is present which:
    a) coordinates all Fort Hood activities to prevent or minimize impacts;
    b) maintains a database of environmental resource information; and
    c) conducts programs for preventive and mitigative actions.

Following is information on specific measures in effect at Fort Hood for the conservation of the karst species of concern.

Management Plan

This report represents the cumulative efforts of Fort Hood to eliminate, mitigate, and prevent harm to the species of concern. It is written in the format of a USFWS recovery plan to best address past and current threats and management actions, and to efficiently propose and coordinate future management action for the species, including an Endangered Species Act Section 10 consultation with USFWS, if any or all of the species are listed as endangered or threatened. By proposing a plan for all species of concern, not just those proposed for endangered listing, Fort Hood can take a broader and more effective ecosystem-based approach to species management, similar to habitat conservation plans.

Karst and Biospeleological Surveys

Studies of caves on Fort Hood began with biological collections in Nolan Creek Cave, Shell Mountain Bat Cave, and Tippit Cave in 1963 and 1964. A few additional caves were located and surveyed during the 1960s. No other studies were conducted on Fort Hood until 1990 when a reconnaissance trip was made to determine if Fort Hood was likely to contain some of the endangered species present in Williamson County to the south.

The current phase of cave research began in 1991, when USA CERL contracted biological study on Fort Hood (Reddell (1993). All previously known caves and karst features on Fort Hood were examined. The studies entailed surveys of the caves' layout from which all other research could be overlain for meaningful analysis. Biological collections were conducted and specimens sent to taxonomists specializing in those animals for authoritative identification.

Between 1991 and 1998 many new features were found. Although no transect surveys have been conducted on Fort Hood, areas already known to contain caves were covered fairly completely as incidental efforts in collecting, mapping, and locating those caves. Special attention was devoted to the remarkable complex of caves in areas 74 and 75 and the Rocket River Cave System was extended to more than 2500 meters in length. Numerous filled sinkholes were found and these were excavated. These excavations produced some of the longer and deeper caves on Fort Hood and resulted indirectly in the discovery of several new endemic species. A problem in the early years of work was the absence of adequate aerial photographs or other means of accurately locating caves. As a result, considerable time was spent in conducting surface surveys to provide locations for caves, often in extremely remote areas.

The 1998-1999 field season was largely devoted to conducting searches for new features in areas not yet visited or poorly known. A total of 58 new karst features were documented. Unfortunately, concerns over archeological remains impacted by excavations have prevented the study of these features. Recent studies have included karst surveys and limited excavations under the supervision of an archeologist. This has resulted in the discovery of additional caves, including some containing endemic species.

An important part of the study for the last few years has been the taxonomic description of the new species discovered on Fort Hood. This led to the publication of a monograph devoted largely to species on Fort Hood (Reddell and Cokendolpher, 2001c). A second monograph includes description of additional Fort Hood species (Cokendolpher and Reddell, 2004). These taxonomic studies are continuing with description of additional species.

Actions Against the Destruction, Modification, or Curtailment of Habitat

Trash from ranching activities that pre-date Fort Hood filled two caves. This trash has been removed. The trash removal has helped restore the caves' natural ecosystems. Excavation of sinkholes and within caves on Fort Hood has been vital to understanding and managing the species of concern. Of the 39 caves containing the species, 20 were opened by excavation (including those deliberately sealed by ranchers), and the extents of others were significantly expanded by excavation. Care has been taken in each excavation to not modify the cave more than needed. In most cases, biological collections were made the same day or shortly after the excavations were complete to document the fauna present at such times. Subsequent biological studies did not indicate any degradation of the habitat; if anything, ecosystems were more robust due to slightly greater nutrient input by more efficient cave cricket foraging and entry of raccoons and other mammals.

Bats or evidence of bats has been found in seven Fort Hood caves. Bats were historically known to inhabit Egypt Cave and Tippit Cave in large numbers but only an occasional *Pipistsrellus subflavus* has been found in Tippit Cave. Shell Mountain Bat Cave contains a significant maternity colony of *Myotis velifer*. When first visited no bats were found in the Rocket River Cave System, although extensive deposits of guano were present in the Doubletree Cave section. Bats have since been observed in significant numbers in Rocket River Cave. A gate has been installed at Shell Mountain Bat Cave to prevent disturbance of that colony. Vegetation has been removed around other caves to see if bats will return to the caves. While large bat colonies, such as those of the Mexican free-tailed bat, *Tadarida brasiliensis mexicana*, usually result in excessively high nutrient inputs for highly evolved troglobites like the species of concern, small bat colonies often provide sufficient nutrients to make the ecosystems for the species of concern more robust rather than displacing them (USFWS, 1998). The large deposits of guano in Shell Mountain Bat Cave may explain the absence of highly evolved troglobites in that cave.

Soil Erosion

A program of prescribed burns to restore rangeland habitat, enhance soil stability, and control the non-natural spread of invasive vegetation, primary Ashe juniper or "cedar" is present at Fort Hood. Junipers are often selectively removed, sometimes by hand, but mainly by mechanical means. Some of the apparatus used cuts down and mulches the trees in place to help produce and stabilize soils. Bulldozers are also used on occasion, which increase soil erosion in the short term until stabilizing vegetation takes root.

Water Quality

No physical actions have occurred to prevent spills of hazardous materials along roadways from entering caves. With the exception of caves in Training Areas 74 and 75 no caves in the area that contain species of concern receive significant runoff and contain water. Recent road construction near Plateau Cave No. 1 has modified drainage into that cave. Recommendations for correcting the problem have been made. Research is continuing to carefully search the installation for additional caves and karst features.

Training Activities

Nineteen gates have been placed on entrances of Fort Hood caves. The gates prevent accidental injury or death during training maneuvers, and thus the reaction to hastily fill the caves in response. Their placement has also greatly reduced and in some cases eliminated trash being tossed into caves. The gates provide the appropriate perception that the caves are something of importance and concern.

Over-utilization for Commercial, Recreational, Scientific or Educational Purposes

Caves on Fort Hood are not used for commercial or recreational purposes. All biological studies of karst species have been coordinated under one set of researchers, which with prudent and as-needed collecting of specimens virtually eliminates the potential for inadvertent over-collection of species. Results from biological monitoring of caves on Camp Bullis and Sun City-Texas near Georgetown suggest that annual to semi-annual use of some caves for educational purposes does not measurably harm the species of concern. Reddell et al. (1999) suggest that educational contact with karst ecosystems is beneficial by fostering public understanding and support of rare and endangered karst species.

Disease or Predation

The preservation of large, undisturbed tracts of land is probably responsible for less fire ant infestation at Fort Hood than seen in caves in the surrounding urbanized areas. A preliminary fire ant control study was conducted to determine the feasibility of control on Fort Hood. A study on the effect of fire ants on karst invertebrates is presently underway.

Other Natural or Man-made Factors

To reduce the impact of trespassing onto Fort Hood and its caves, the caves that are most easily found have been securely gated. The gates are designed to allow the free passage of air, water, and cave life to minimize their impact on the cave ecosystems. Fort Hood personnel restrict maps with cave locations to their files and to researchers and other personnel on an as needed basis.

Management Plan

Management Strategy

This management plan is designed to provide detailed steps for management of the species of concern at Fort Hood and to outline a general strategy for situations not covered by specific management actions. The management plan has two goals:

1) preservation and protection of the species of concern and their habitat in perpetuity, within the limits possible through the caves, land, and authority of Fort Hood;
2) ensure the species' survival, genetic diversity, and evolution in a manner consistent with the delisting or downlisting of endangered and threatened species as recognized by the USFWS (1994).

As shown in Figures 1-7, Fort Hood occurs in three karst fauna regions. The regions, as described earlier in this report, are defined based on geologic and hydrologic continuity and the distribution of troglobitically advanced species. Subregions are zones within karst fauna regions that have different faunal assemblages.

Karst fauna regions and subregions can be further divided into "karst fauna areas." USFWS (1994) described the karst fauna area as "known to support one or more locations of the listed species [species of concern for this management plan] and is distinct in that it acts as a system that is separated from other karst fauna areas by geologic and hydrologic features and/or processes that create barriers to the movement of water, contaminants, and troglobitic fauna." The purpose of the karst fauna areas in managing the species of concern is to establish areas where a catastrophic event (i.e., contamination, quarrying, flooding, etc.) that may kill species or destroy habitat in one area, would not impact species or habitat in other areas.

Per the USFWS (1994) recovery plan for related endangered invertebrates in Travis and Williamson counties, Texas, implementation of this management plan would require protection and preservation of at least three karst fauna areas within each karst fauna region for each species of concern present. In addition to the requirement of that recovery plan, to maintain genetic diversity throughout the karst fauna region, the subregions must receive equal consideration of at least three protected and preserved karst fauna areas per subregion per species. Overlapping of species in karst fauna areas is desirable because it preserves areas with high biodiversity.

Karst fauna areas are equivalent to each known cave in the Nolan Creek and Seven Mile Mountain karst fauna regions. These caves are shallow and are not near major roads.

All of the caves containing species of concern in the Rocket River Cave karst fauna subregion are or once were part of a single hydrological system. It is likely that any catastrophic event in this area would impact all caves in the area, with the possible exception of Tippit Cave that is now an isolated segment of the system.

Caves in the Egypt Hollow karst fauna subregion are in an area of little human impact, except for artillery bombardment.

Caves in the Northeast Fort Hood karst fauna subregion occur either in clusters of two or more nearby caves or are isolated from other caves. With few exceptions, these caves are shallow and lie above the water table. The few caves that do contain pools do not have significant horizontal extent at depth and it is unlikely that contaminants reaching the water table would significantly affect the terrestrial fauna. Sufficient distances to prevent a catastrophic incident at one from affecting another separate the caves or cave clusters. Caves in those regions tend to be vertically developed for efficient recharge of their aquifers, and thus have relatively little horizontal extent above the water table that may connect to other caves with species of concern. Little direct information is available on caves and conduit development below the water table at Fort Hood, but what is available supports the conceptual model of karst aquifers that many caves will be hydrologically linked. Since all of the invertebrate species of concern occur above the water table, they will not be directly impacted by a significant groundwater contamination incident in another karst fauna area. However, fumes from contaminants spilled into one karst area are known to rise from the aquifer into caves in other karst areas, even if the caves do not allow human access to the water table (e.g., Russell, 1987). The direct impact of such fumes on the species of concern is not known, although with certain fumes, fires and explosions are possible. There is insufficient information to precisely predict groundwater flow paths in most areas of Fort Hood to be certain where contaminants would or would not travel; therefore, until additional information is available, karst fauna areas are primarily defined on their degree of distinctiveness above the water table.

Table 4 groups the 36 caves with species of concern by karst management regions and subregions into 27 karst management areas. Table 5 identifies the karst fauna regions and subregions in which each species of concern occurs, and the number of karst fauna areas needed to preserve and protect the species within the minimum three caves per species per karst region or subregion goals of this management plan.

Table 4
CAVES OF FORT HOOD KARST MANAGEMENT AREAS

Karst Management Areas	Caves Within Each Karst Management Area
Nolan Creek Karst Fauna Region	
1	Nolan Creek Cave
Seven Mile Mountain Karst Fauna Region	
2	Seven Mile Mountain Cave
North Fort Hood Karst Fauna Region: Northeast Fort Hood Subregion	
3	Big Red Cave
4	Buchanan Cave
5	Bear Springs
	Big Crevice
	Camp 6 Cave No. 1
	Coyote Den Cave
	Figure 8 Cave
	Hidden Pit Cave
	Lucky Rock Cave
	Lunch Counter Cave
	Peep in the Deep Cave
	Seven Cave
	Talking Crows Cave
	Treasure Cave
	Valentine Cave
6	Copperhead Cave
	Keyhole Cave
7	Mixmaster Cave
8	Monkey Walk Cave No. 1
	Monkey Walk Cave No. 2
9	Keilman Cave
	Triple J Cave
10	Streak Cave
11	Cowbell Cave
	Fellers Cave
	Rainy Day Cave
12	Owl Mountain Cave
13	Bumelia Well Cave
	Rugger's Rift Cave
14	Newby Cave
15	Violet Cave
16	Sanford Pit Cave
17	Price Pit Cave
18	Skeeter Cave
19	Estes Cave

20	Moffat Pit Cave
21	Lucky Day Cave
22	West Corral Cave No. 4
North Fort Hood Karst Fauna Region: Rocket River Cave Subregion	
23	Rocket River Cave System
24	Tippit Cave
North Fort Hood Karst Fauna Region: Egypt Hollow Subregion	
25	Chigiouxs' Cave
	Cornelius Cave
26	Egypt Cave
	Ingram Cave

Table 5

NUMBER OF KARST MANAGEMENT AREAS PER SPECIES AND NEEDED TO MEET MANAGEMENT GOALS

Species of Concern	**Karst Fauna Region: Subregion**	**Known number of karst management areas**	**No. of areas needed for protection (minimum 3/region or subregion)**
Cicurina caliga	North Fort Hood: Northeast Fort Hood	2	all
Cicurina coryelli	North Fort Hood: Egypt Hollow	1	all
	North Fort Hood: Northeast Fort Hood	1	
	North Fort Hood: Rocket River Cave	1	
Cicurina hoodensis	North Fort Hood: Northeast Fort Hood	3	all
Cicurina mixmaster	North Fort Hood: Northeast Fort Hood	1	all
Cicurina troglobia	Seven Mile Mountain	1	all
Neoleptoneta paraconcinna	North Fort Hood: Northeast Fort Hood	1	all
Tartarocreagris hoodensis	North Fort Hood: Egypt Hollow	1	all
	North Fort Hood: Northeast Fort Hood	2	all
Speodesmus castellanus	North Fort Hood: Egypt Hollow	1	all
	North Fort Hood: Rocket River Cave	1	all

	North Fort Hood: Northeast Fort Hood	9	3
Texoreddellia n. sp.	Nolan Creek	1	all
	Seven Mile Mountain	1	all
Rhadine reyesi	North Fort Hood: Northeast Fort Hood	6	3
	North Fort Hood: Rocket River Cave	1	all
Batrisodes n. sp.	North Fort Hood: Northeast Fort Hood	1	all
Batrisodes feminiclypeus	North Fort Hood: Northeast Fort Hood	1	all
Batrisodes gravesi	North Fort Hood: Northeast Fort Hood	7	3
Batrisodes wartoni	North Fort Hood: Egypt Hollow	1	all
	North Fort Hood: Rocket River Cave	1	all
Plethodon n. sp.	North Fort Hood: Rocket River Cave	1	all
	North Fort Hood: Northeast Fort Hood	6	3

With the exception of *Cicurina* (*Cicurella*) *hoodensis*, *Speodesmus castellanus Rhadine reyesi*, *Batrisodes gravesi*, and *Plethodon* n.sp. all species have three or fewer caves per species per region or subregion. Five of the species are only known from single karst areas, which is typically one cave for each area. The discovery of additional localities for these species in different karst management areas is critical in meeting the management goals. This is especially true if activities or accidents require or result in the loss of a karst fauna area. Additional localities provide Fort Hood with greater flexibility in management if necessary, and a supportive role for the conservation of species of concern that occur in caves beyond the installation's boundaries.

When more than the minimum number of karst management areas are known, and if a need arises to target some for conservation while others may be impacted or lost, priority should be given to the first three of the following circumstances and subtracted for the fourth:

1) high biodiversity within the karst management area;
2) presence of multiple species of concern within the karst management area;
3) presence of species known from less than three karst management areas;
4) low species populations or habitat of otherwise marginal quality.

The first two points are important to preserving genetic biodiversity of the karst ecosystems, which also protects species not currently known or considered species of concern. The third point is important where one karst management area may have high general biodiversity and/or multiple species of concern, but its species are protected by three or more other areas. In such cases, a cave with less biodiversity and fewer species of concern should receive preferential protection since at least one of its species is known just from that karst area and perhaps only one more. The fourth point identifies cause for discounting protection of an area if needed, but it should not be a consideration if the area is one of no more than three containing a certain species.

A second important part of the management strategy is the delineation of karst fauna areas targeted for conservation. The size and shape of an area should be sufficient to maintain microclimatic conditions in its cave(s), water quality and quantity consistent with natural drainage, and a surface area supportive of native plants and animals. If the watershed of a karst fauna area is sufficiently large, berms, curbs, or other water diversion structures may be used to divert small amounts of potentially contaminated surface water away from the area, while not affecting the overall volume of recharge into the site.

Elliott (1994a) found that cave crickets, which are critical to the maintenance of cave ecosystems, forage mainly within 50 m of cave entrances. Therefore, natural vegetation in karst fauna areas should be maintained within at least a 50-m-radius of cave entrances and sinkholes or other karst features probably connected to the cave. Elliott (personal communication, 1998) believes that even where a 50-m-radius is maintained, if the karst area is essentially an ecological island amid an urban landscape, that preservation of the species may not be possible. He reported overall decreases in the observed species of biologically monitored caves surrounded by increasing densities of urban development, and attributed them to decreased food input from raccoons and greater impacts from fire ants, roaches, pillbugs, and other competitive or predatory non-native species. So long as Fort Hood retains its predominantly undeveloped setting, these issues should not affect management of its karst fauna areas or species of concern. Recent considerations indicate that the minimum buffer for cave crickets should be a 50-m-radius around the groundwater drainage basin for the cave.

Fire ants have adversely impacted cave fauna throughout Central Texas and have been noted in many caves in Fort Hood. Fire ants typically forage within 25 meters of their nests. A 25-meter buffer zone should be set aside around the buffer zone for cave crickets. This will provide additional protection for the cave cricket population in the vicinity of the caves, assuming that adequate fire ant control is conducted in the cave cricket buffer zone.

The third important part of the management strategy is its implementation. At Fort Hood, this would include developing appropriate regulations, launching chain of command notifications and procedures, acquiring funding as needed, and establishing procedures and personnel responsible for implementing the management plan. Implementation of the management plan should recognize that understanding of the species of concern and the complicated karst hydrogeologic environment they inhabit is limited, and in cases of uncertainty, the default action should be to protect and preserve larger areas and more locations. Personnel implementing the plan should allow it to be flexible and modified following acquisition and analysis of new data.

Management Objective and Criteria

Objective

The objectives of this plan are to:

1) preserve and protect the species of concern and their habitat in perpetuity, within the limits possible through the caves, land, and authority of Fort Hood;
2) ensure the species' survival, genetic diversity, and evolution in a manner consistent with the delisting or downlisting of endangered and threatened species as recognized by the USFWS (1994).

Criteria

The objectives of this plan will be satisfied by the following factors:

1. Preservation and protection of three karst fauna areas (if three exist) within each karst fauna region or subregion per each species of concern. If fewer than three karst fauna areas occur within a region or subregion, then all areas must be protected, even if the species is present in more than three karst fauna areas of other regions or subregions. By definition, the karst fauna areas must be sufficiently separated so that degradation of an ecosystem in one area does not adversely impact the other ecosystems. To be considered "protected," a karst fauna area must include sufficient area to preserve its cave(s) and the immediate surface area on which the karst fauna depends.

2. Administrative and other appropriate assurances are in place for criteria no. 1 to be carried out in perpetuity. The management plan is intended to assure compliance with the letter and spirit of the Endangered Species Act by proactive actions that will help conserve species proposed for endangered listing, and by preventative actions to decrease the chance of other species being put at risk and considered for listing. The objectives of this plan will need to be continued in perpetuity, unless circumstances change where the species of concern are no longer at risk and do not require this intervention. Should Fort Hood ever be sold or separated in whole or in part, responsibility for the appropriate management of any former Fort Hood karst fauna areas should be passed by deeded restriction and/or other binding agreement to all subsequent owners.

Management Plan Outline

Below is an outline of the tasks needed to meet the objectives of the plan. Narrative descriptions of the tasks are discussed in the following section and are followed by specific management recommendations for the 18 karst fauna areas.

1. Identify karst fauna areas needed to meet the management plan criteria.
2. Determine the appropriate size and shape of the karst fauna areas targeted for management.
3. Provide protection in perpetuity to targeted karst fauna areas.
   3.1 Coordinate with USFWS and other agencies.
   3.2 Review and update Fort Hood regulations as needed.
4. Implement conservation measures and manage targeted karst fauna areas.
   4.1 Apply USFWS fire ant management techniques.
   4.2 Identify and protect important sources of nutrients into karst ecosystems.
   4.3 Determine and implement appropriate means to prevent vandalism, dumping of trash, and unauthorized human entry.
   4.4 Other actions as needed.

5. Additional research.
    5.1 Conduct additional karst and biospeleological surveys.
    5.2 Continue hydrogeologic studies of karst fauna areas that are currently incomplete.
    5.3 Conduct additional studies on the ecology of the species of concern.
    5.4 Revise the karst species management plan as needed.
6. Education
    6.1 Develop educational programs to raise awareness and encourage protection of karst ecosystems by Fort Hood personnel.
    6.2 Develop educational programs on karst ecology and hydrogeology to help key Fort Hood personnel with the management of the karst fauna areas and the species of concern.
    6.3 Develop educational information for public relations.
7. Monitoring

Management Plan Narrative Outline

1. Identify karst fauna areas needed to meet the management plan criteria. In some areas, existing land use of Fort Hood preserves and protects the karst fauna areas with little additional action and only occasional maintenance. In other areas, intensive training activities (especially involving tanks and other heavy vehicles) have caused considerable degradation to the habitat. Whereas some karst fauna areas occur within areas that are largely or entirely within their natural states with little or no impact from human activities others have been severely impacted. The purpose of identifying karst fauna areas here is to prioritize their importance should circumstances develop that may threaten or harm their ecosystems. The primary considerations in prioritization are biodiversity, number of species of concern present, number of karst areas known per species, and quality of habitat. Secondary factors to consider include potential threats, present, past, and projected future surrounding land use, management feasibility, and importance to the regional aquifer.

Based on these considerations, Table 6 provides a matrix by which the karst fauna areas are prioritized for conservation. The table is solely for karst fauna areas that occur in a sufficient number of localities to exceed the minimum preservation criteria of three karst fauna areas per karst fauna region or subregion. The matrix of Table 6 prioritizes the ecological importance of the karst fauna areas. Thus, should it become necessary to harm or potentially harm one or more the areas, those with greatest ecological value can be identified and protected.

Table 6 was designed to primarily weigh the factors reflecting biological richness and threats to the ecosystem, with secondary importance given to management and related factors. The matrix was tested by calculating data in various ways until the results fit our professional assessment of the karst fauna areas. Among the factors listed above, habitat quality was considered under “Potential threats” and management feasibility was considered approximately equal for all sites and was not included.

The first line of data in the table describes the calculation. The number of species of concern for a karst fauna area is multiplied by ten. The resulting number is then added to the area’s number of non-species of concern troglobites, which is first multiplied by five. This number is then added to the area's number of non-troglobitic invertebrates to produce the area's biodiversity value. If there were no threats or potential management problems affecting the areas, this value could be used for prioritization. However, threats exist that effect the quality of the ecosystems. "Potential threats" include existing impacts, such as fire ants, and existing conditions that may harm a karst area, such as spills from a roadway. Since the potential impact of the threats is directly proportional to the biodiversity of a karst fauna area, the threats are represented on a percentage scale for their likely harm to each ecosystem. Zero is the lowest possible value and 1 (100%) is the highest. The potential threat value is multiplied by the biodiversity value, and the result is subtracted from the biodiversity value. To that number, points may be added or subtracted for land use and aquifer importance to obtain the matrix total value.

For Table 6, potential threats were estimated as: 0.1 for fire ants in the area, 0.2 for light fire ant cave infestation, 0.4 for moderate fire ant cave infestation, 0.2 for areas in the firing ranges where soil erosion or possible ordnance contaminants may occur, and 0.1 to 0.3 for areas in streambeds or along roads where they are susceptible to spills and soil erosion. Land use was assigned three values: -5 for use adverse to the karst ecosystem, 0 for land that is not intensively used or not in clearly harmful ways, and 5 for use that maintains the land in its natural state that is most beneficial to the ecosystem. Aquifer importance was rated between 0-5 points based on the estimated recharge that occurs in the karst fauna area, and how vulnerable the aquifer may be to contaminants in that area.

It is important to note that the values given in Table 6 can be changed. Some may change as additional species are discovered. Major change is possible with karst fauna areas listed with high potential threats. Management actions may reduce the threat from fire ants, spills, and other activities, thus raising the ecological value of the karst fauna areas.

While Table 6 includes all karst areas that contain each species, only those listed as having one species of concern could be considered as potentially acceptable for impact. Additional discoveries of any species of concern will increase the demonstrated likelihood for the species' survival and allows for greater flexibility in their management. The results of Table 6 or otherwise meeting this management plan's goal of three karst areas per region/subregion should not be considered justification to casually impact the karst areas; the species of concern are still rare. Table 6 is meant to help with prioritization when other management avenues to protect the areas are not available.

2. Determine the appropriate size and shape of the karst fauna areas targeted for management. The karst fauna areas should include area sufficient to preserve and protect the nutrient input, moisture, and microclimate of their karst ecosystems, and the water quality and quantity entering the ecosystems. The areas should also prevent or discourage the entry of non-native species harmful to the ecosystems, such as fire ants. For the recommended sizes and shapes of the 18 karst fauna areas, see the following section: Specific Management Actions for Karst Fauna Areas with Species of Concern.

3. Provide protection in perpetuity to targeted karst fauna areas. This task refers to administrative actions and procedures needed to ensure the protection and preservation of the karst fauna areas and their species of concern.

3.1 Coordinate with the USFWS, TPWD, and other agencies. If some of the species of concern are federally listed as endangered or threatened, Fort Hood will need to request an Endangered Species Act Section 10 consultation with the USFWS. The purpose of the consultation will be to coordinate management actions to assure compliance with the Act, with the goal of minimizing impacts and threats to the species for eventual downlisting or delisting.

3.2 Review and update Fort Hood regulations as needed. Fort Hood has established environmental protection measures for activities at Fort Hood. These regulations should be periodically reviewed and updated as appropriate following generation of new information, and as may be required for compliance with the requests of other agencies.

4. Implement conservation measures and management of targeted karst fauna areas. This task refers to field actions and procedures needed to ensure the protection and preservation of the karst fauna areas and their species of concern.

4.1 Apply USFWS fire ant management techniques. Campbell (1995) described the methods recommended by the USFWS for short-term and long-term control and eradication of fire ants that threaten karst fauna areas. Those methods should be followed.

4.2 Identify and protect important sources of nutrients into karst fauna areas. Karst ecosystems are highly dependent on food input from the surface. This includes fresh and decaying vegetation that falls or washes into caves, plants that provide forage to cave crickets and other trogloxene species, roots that extend into karst ecosystems, and animals that may periodically use caves or otherwise add some form of nutrient energy to the karst ecosystem. Protecting these nutrient sources may require protection of drainage basins, control of exotic species, prevention of soil erosion, and control of certain human activities.

4.3 Determine and implement appropriate means to prevent vandalism, dumping of trash, and unauthorized human entry into karst fauna areas. Cave gates and fences are often effective at reducing and eliminating trespassing and its associated problems. Whenever they are built, gates and fences should be designed to allow the free passage of air, water, cave life, and organic debris, and thus minimize the structure's impact on the cave's ecosystem. During construction of a gate or fence, disturbance of the soil and vegetation should be minimized to avoid soil erosion, attraction of fire ants, and catching the attention of potential trespassers. Regardless of the degree of care, a gate may adversely impact a cave's ecosystem. Therefore, gates and fences should only be used where discovery and unauthorized visitation is likely. Caves in remote areas of Fort Hood, or with small entrances hidden by vegetation or rocks, are unlikely to be found or disturbed and should be left ungated.

4.4 Other actions as needed. The area surrounding Fort Hood is primarily ranchland. Most of the karst fauna areas occur in remote areas not likely to be affected by neighboring land use activities or changes.

5. Additional research. This task answers remaining or arising questions about the status and needs of the species of concern to ensure their protection and preservation with the most accurate information available.

5.1 Conduct additional karst and biospeleological surveys. Considerable karst and biospeleological research has been conducted at Fort Hood, yet much more remains to be accomplished. All open caves have been carefully studied. Research is incomplete in a few caves, and many karst features are known that will likely open to caves following excavation, potentially expanding the knowledge base on the distribution of the species of concern. No area of Fort Hood can be considered adequately studied. Although some areas have been studied in more detail than others, new features have been accidentally found in areas that were thought to have been well covered. Most known features occur near roads or firing lanes. Surveys in 1999 were conducted through random searches in more remote areas and many features, including some open caves, were found. Many features have been found in training areas 5A and 5B that require excavation. Opening of these features may well reveal additional populations of *Cicurina mixmaster* and *Batrisodes feminiclypeus.* While this discussion has focused on locating additional caves and karst features, it assumes that appropriate biological and hydrogeological studies, as conducted thus far, will be conducted to in the future to fully evaluate those features.

5.2 Continue hydrogeologic studies of karst fauna areas that are currently incomplete. Hydrogeologic research is needed to delineate most karst fauna areas and it is not possible to provide this information.

5.3 Conduct additional studies on the ecology of the species of concern. Biological research in several Fort Hood caves is incomplete (per Table 2, cave numbers: 1-9, 11, 13-21, 24, 26-31, and 33). The list of caves containing species of concern may expand or shrink as species collected to date are described or identified. Even some long-studied caves continued to yield new, rare species that require additional trips to the caves and biological research. Some new species found at Fort Hood require description, which has been beyond the scope of biospeleological research conducted to date. Descriptions are needed to determine the species' ecological and legal status. Some new species may prove unrelated to those included here and would be unaffected by any future listing. Results of these studies will likely change the number of species of concern, the number of karst fauna areas, and the prioritized importance of each.

5.4 Revise the karst species management plan as needed. This management plan should be reviewed every 3-5 years and revised if needed. The frequency of review should be flexible and would depend on the type and level of research conducted at Fort Hood, and changes in land use at or surrounding the installation. Within the 3-5 year time frame, some species identifications will likely be verified or determined, new karst fauna areas may be found, the boundaries and management needs of existing karst fauna areas may change, and regulatory changes may also occur. While the bulk of the management plan will probably remain intact, it is likely that several important specific changes will need to be made.

6. Education. This task is aimed at raising the level of awareness about the species of concern to facilitate their protection and preservation.

6.1 Develop educational programs to raise awareness and encourage protection of karst ecosystems by Fort Hood personnel. Environmental and endangered species awareness programs and publications are provided to Fort Hood personnel. It should be a simple matter to supplement those programs and publications with information about the species of concern and the karst fauna areas. Activities allowed or prohibited within the karst fauna areas would generally be consistent with other management actions required, and should not significantly raise the level of complexity for training or management.

6.2 Develop educational programs on karst ecology and hydrogeology to help key Fort Hood personnel with the management of the karst fauna areas and the species of concern. Personnel with the Ecological Services office at Fort Hood are well informed about the issues and needs of the species of concern. However, educational material or an educational program should be provided to new staff to the Ecological Services office and to other Fort Hood personnel who may play key roles affecting species management.

7. Monitoring. All karst fauna areas targeted for conservation should be monitored to determine the success or failure of the management actions that are implemented, and to guard against irreversible declines in the species' status. The status of the species of concern, their karst fauna areas both above and below ground, and existing or potential threats to either should be monitored on a basis as recommended by the USFWS. Monitoring criteria should be developed that are as quantitative as possible to minimize sampling or interpretational bias, and for comparison between monitoring periods and other observations. The results of the monitoring should be assessed periodically to determine if changes, additions, or deletions to the conservation program are needed.

Any monitoring program should take care not to adversely impact cave fauna. It is both impractical and probably harmful to do intensive regular detailed monitoring of many of the small caves. Larger caves, where only selected areas are monitored, can be safely monitored 2-4 times a year. In the event major land use modifications are planned in the vicinity of a karst fauna area, one or more detailed biological surveys of the cave should be conducted, with follow-up monitoring after modification. Any cave in a potentially impacted karst fauna area should be studied immediately after the event. Additional surveys should be conducted if there is evidence of an adverse impact on the karst ecosystem or, especially in the event of a spill of hazardous materials, several surveys to determine if pollution is occurring later. Caves should also be monitored if heavily impacted by flooding or fires.

Specific Management Actions for Karst Fauna Areas with Species of Concern

Karst areas are well known to have complex groundwater flow paths that are very sensitive to contamination and disturbance. The following recommendations are based on this premise, data from the studies of Veni and Elliott (1994) and Veni et al. (1995, 1996, 1998a, 1998b, 1999), and are taken directly from those studies and updated or revised as needed. The following management actions for karst fauna areas are given in two sections. The first section described actions that apply to all karst fauna areas. The second section describes actions specifically for each karst fauna area. Multiple recommendations are presented in descending order of importance. The karst fauna areas are presented per their order in Table 4, by karst fauna region and subregion.

Management Actions for all Karst Fauna Areas

1. Preserve the general ecology and water quality and quantity. Karst fauna areas will be left undeveloped and in their natural state, maintaining natural vegetation and drainage patterns. Their exact boundaries will vary according to the conditions of each site. The boundaries will reflect the minimum limits that would likely prevent contaminated surface runoff from entering the karst ecosystem either via cave entrances or nearby fractures and karst features. Sewage and septic systems, vehicular traffic, electrical transformers, and related equipment or other activities that may contain, use, store, produce, or dispose of hazardous materials should be prohibited from the areas. If future roads, facilities, or activities must be sited uphill of karst fauna areas, they should cross as small a portion of the drainage zones as possible and not result in an appreciable increase or decrease in runoff into the areas. Impermeable berms should be placed to prevent runoff or spilled materials (if applicable to the activity or facility) from entering the areas.

2. Preserve surface area for cave crickets. In addition to the conditions and hydrologic boundaries described in the previous paragraph, karst fauna areas will also include a minimum 50 m radius around the footprint of each cave, and other possible points of entry to the cave, for ecological maintenance of cave crickets. Establishing the radius per the cave's footprint rather than just the entrance will account for potentially important cricket egress and entry points that may not be apparent. Additionally, a potentially important percentage of the cricket population resides in small karst features, and under rocks and debris near cave entrances, and does not always return to the caves in the morning. The footprint of the cave should thus better approximate the broader area from which crickets emerge to forage

4. Control or eradicate fire ants. Fire ants in karst fauna areas should be controlled or eradicated with the following methods recommended by the USFWS (Campbell, 1995). Only boiling water should be used within an 11-m radius of a cave entrance. Fire ant mounds will not be disturbed prior to treatment, but as the boiling water is being poured, the mounds should be excavated to ensure that the bottoms of the mounds have been saturated. After treating with boiling water, commercial poisonous fire ant bait (e.g., Logic, Amdro, etc.) should be placed between 11-90 m from a cave entrance (boiling water can also be used in this area, but is not always logistically feasible). Small amounts should be used to prevent the bait from being introduced into the karst ecosystem by cave crickets or other species. However, sufficient quantities should be used to discourage ants missed by the boiling water or new colonies of ants from re-infesting the area; the specific amount needed will depend on mound size and activity. Bait should only be placed near fire ant mounds, not native ant mounds, and set on sheets of paper or foil that are held to the ground by rocks or stakes. The sheets allow for easy removal of unconsumed bait before cave crickets can eat it. In some cases, it is useful to attract the fire ants with non-toxic bait like tuna, cheese, peanut butter, or meat, and replace it with the toxic bait once discovered. Fire ant treatments should be performed twice each year, during the spring and fall when fire ants are most active. Boiling water treatments should be conducted in mid-mornings as the sun is starting to warm the mounds and when most ants will be congregated near the top. Baits should be placed before noon, but after morning dew has dried, and any excess picked up before nightfall. Baits should be placed during clear, dry weather with no forecast of rain for that day. Baits can be applied per the manufacturers' recommendations beyond 90 m. If more intensive treatment is needed, it should be coordinated with the USFWS; a permit may be needed if some of the karst species are listed as endangered.

5. Cave gates. Certain caves may warrant gating or fencing if they are near the boundaries of Camp Bullis or in locations where they will likely be vandalized and their ecosystems harmed. Gates and fences should only be constructed according to the best designs recommended by the USFWS, and should permit the free flow of air, water, nutrients, and animals such as full-grown raccoons. Any caves harboring bats, or which could reasonably be expected to be recolonized by bats should not be gated unless absolutely necessary. In such a case, the design should be suitable for the passage of bat species inhabiting or most likely to inhabit the cave, with few vertical supports and horizontal angle iron bars about 15 cm apart. Some bat species will not tolerate gates. If experience shows that certain caves are well known and their gates are frequently tampered with, then signs should be posted stating the commander's restrictions on access, the reasons for the karst fauna area and gate, and both the military and civilian penalties for violating the commander's directive, harming cave species, tampering with the gate, or other pertinent statutes. Signs should not be posted if they would draw attention to caves that are not otherwise known. All cave gates and fences should be regularly inspected, especially following storms if floodwaters course through and may clog the gates or fences with debris.

6. Prohibit use of chemicals at nearby locations. The application of pesticides, herbicides, and other related harmful chemicals should be prohibited within a 200-m-radius of each karst fauna area unless authorized by a qualified biologist and/or the USFWS.

8. Control new growth juniper in karst fauna areas. Although there are no specific data on the impact of Ashe juniper growth on karst invertebrates, there is sufficient evidence to demonstrate that dense juniper growth reduces the infiltration of water into the subsurface (Thurow and Taylor, 1995). Young, dense stands of juniper should be removed or thinned in karst fauna areas. Removal of older juniper trees is not recommended because of excess disturbance to soil and the potential of increasing fire ant activity. In addition to the reduction of water infiltration into caves, juniper growth crowds out grasses and other plant species that may provide food for cave crickets. Surveys of invertebrates in the soil and under rocks in juniper thickets have demonstrated a major reduction in the variety of species present versus those in other types of vegetation. Berlese samples of leaf litter from cave entrances or that has washed deeper into caves contain a greatly reduced number and diversity of invertebrates when the litter is mostly composed of juniper litter when compared with the litter of other species (unpublished observations). This obviously decreases the available food supply for the true cavernicole fauna.

9. Identify spider species. Continued work is needed in rearing juvenile species of troglobitic spiders for identification. Seven caves are known which do not have adequate material for taxonomic determination. Some or all will likely prove to belong to one of the described species, but identification will aid in determining the number, size, and configuration of karst preserves. When possible, adult males of blind *Cicurina* spp. should be obtained. Few adult males have been collected in Fort Hood caves. According to Gertsch (1992), only 7 of the 46 described eyeless *Cicurina* species from Texas caves are known from adult males. Apparently, adult males are short lived in the wild and are missed by most collecting efforts.

Management Actions for Karst Fauna Areas – Seven Mile Mountain Karst Fauna Region

Karst Management Area No. 1: Seven Mile Mountain Cave

Management area summary. Seven Mile Mountain Cave is the only known locality for the blind spider *Cicurina* (*Cicurella*) *troglobia* and one of only two localities for the subterranean silverfish *Texoreddellia* ?new species. The cave is a single room about 16 m long and 3.8 m deep (Fig.). Biological collections were made in the cave on 26 May 1999, 28 June 2000, and 29 April 2002.

1.. **Boundaries.** There is no significant drainage into the cave and it is the only known karst feature in training area 24B. In the absence of any evidence of drainage into the cave from surrounding areas the groundwater basin is interpreted as being an elongate area 10 m from the footprint of the cave and 20 m from each end of the cave along the 280° trend of the cave (Fig.). The karst management area encompasses a circle about 640 m in diameter, with the northern boundary ending at the edge of the plateau (Fig.).

2. Biologic research. Additional specimens of the silverfish are needed to determine its taxonomic status.

3. Training and Administrative Issues. The cave is in endangered bird species core habitat.

Nolan Creek Karst Fauna Region

Karst Management Area No. 2: Nolan Creek Cave

Management area summary. Nolan Creek Cave is one of only two known localities for the subterranean silverfish *Texoreddellia* ?new species. The cave is a single passage about 35 m long. A small stream emerges from beneath the entrance collapse and extends for 12 m before water fills the passage. The stream emerges as a spring about 12 m below and 60 m west of the cave entrance (Fig.) Biological collections were made in the cave on 9 Mach 1963, 4 October 1964, 27 January 1990, 17 July 1993, and 25 July 2002.

1. Boundaries. The boundaries for this management area extend 260 m west to a heavily disturbed area and 340 m to the north, east, and south (Fig.). The management area includes a significant area of the drainage extending downstream from Nolan Spring.

2. Cave and hydrogeologic delineation. Although the cave is completely mapped, a hydrogeologic survey is needed to determine the source of water flowing through the stream.

3. Biologic research. Additional specimens of the silverfish are needed to determine its taxonomic status.

4. Training and administrative issues. The cave is in an area of relatively heavy training activity with vegetation removal. The area does not contain endangered bird species.

Management Actions for Karst Fauna Areas

North Fort Hood Karst Fauna Region: Northeast Fort Hood Subregion

Karst Management Area No. 3: Big Red Cave

Management area summary. The cave is a joint-guided passage extending mostly to the west from the entrance. Total depth of the cave is 19.26 m and total length is 107.59 m (Fig.). A second small cave, Little Red Cave, is probably structurally related to the cave. Both cave entrances have been gated. Much of the main passage has been enlarged by miners, presumably seeking treasure. The cave contains four endemic species: the spider *Cicurina* (*Cicurella*) *coryelli*, the millipede *Speodesmus castellanus*, the ground beetle *Rhadine reyesi*, and the antlike litter beetle *Batrisodes* (*Babnormodes*) *gravesi*. Biological collections were made in the cave on 30 April 1998, 5 May 1999, 6 May 1999, and 14 June 2000. The cave is part of an ongoing study of cave cricket foraging behavior.

1. Boundaries: The groundwater drainage area is considered to be about 50 m on each side of the cave along its trend and to extend to about 50 m beyond Little Red Cave (Fig.). The karst management area boundaries are delimited as 340 m to the east of the cave entrance, 290 m south to a major tank trail, 280 m north, and 270 m from the entrance of Little Red Cave to a major drainage channel (Fig.). The location of Little Red Cave at the edge of a major tank trail and of another major trail very near the entrance to Big Red Cave would normally preclude consideration of the cave as a viable preserve area. Much of the area surrounding the cave, however, is core habitat for endangered bird species and the effective area of protection is greater than the defined management area boundaries.

2. Biological research: Additional specimens of *Speodesmus* are needed to verify the taxonomic status of the species in the cave.

3. Fire ants: Fire ants have been found inside the cave. Their impacts should be eradicated or minimized through appropriate treatment.

4. Training and Administrative Issues. The tank trails are heavily used for troop movement, including tracked vehicles. Consideration should be given to protect the cave from accidental damage due to vehicles driving off of the main roadway.

Karst Management Area No. 4: Buchanan Cave

Management Area Summary. Buchanan Cave is entered through a 4.27 m drop. A slope from the bottom leads down into a passage that extends about 12 m to a 10.7 m deep shaft. A lower level passage that periodically contains water extends for 5 m before becoming too small (Fig.). The entrance has been gated. The cave contains six endemic species: the spiders *Cicurina* (*Cicurella*) *caliga* and *C.* (*C.*) *hoodensis*, the pseudoscorpion *Tartarocreagris hoodensis*, the millipede *Speodesmus castellanus*, the antlike litter beetle *Batrisodes* (*Babnormodes*) *gravesi*, and the slimy salamander *Plethodon* new species. Biological studies were conducted in the cave on 8 November 1995, 7 May 1998, 4 November 1998, 5 May 1999, 13 June 2000, and 14 December 2002.

1. Boundaries: The groundwater drainage area for the cave is considered to include about 20 m along the sides of the passage, and 50 m along each end of the cave (Fig.). The boundaries of the management area extend about 300 m west, 180 m south to include a drainage, 300 m north to include a drainage, and 300 m east to include a drainage (Fig.). The drainage areas are included since these mesic areas probably are primary habitat for the *Plethodon* salamanders.

2. Biological research: Additional specimens of lithobiomorph centipede are needed from the cave.

3. Training and Administrative Issues. The cave is in an area that does not receive active training. It lies entirely within core habitat for endangered birds.

Karst Management Area No. 5: (East Moffat Run) Bear Springs, Big Crevice, Camp 6 Cave No. 1, Coyote Den Cave, Figure 8 Cave, Hidden Pit Cave, Lucky Rock Cave, Lunch Counter Cave, Peep in the Deep Cave, Seven Cave, Talking Crows Cave, Treasure Cave, Valentine Cave

Management Area Summary. This large area contains 10 caves containing endemic species as well as numerous smaller caves and sinks that do not contain habitat for troglobites. Big Crevice is an elongate fissure about 15 m long and 2 m deep near the head of a major drainage channel (Fig.). It contains the slimy salamander *Plethodon* new species. It was biologically studied on 13 May 1999, 6 June 2000, and 14 June 2000. Camp 6 Cave No. 1 is a small passage about 21 m long at the bottom of a 7 m deep sinkhole that was originally plugged with sediment (Fig.). It contains two endemic spiders, *Cicurina* (*Cicurella*) *hoodensis* and *Neoleptoneta paraconcinna*. It was biologically studied on 22 February 1996, 20 April 1998, 2 November 1998, 5 May 1999, and 6 June 2000. Coyote Den Cave is a passage about 5 m long at the bottom of a 4.6 m diameter collapse sinkhole (Fig.). The cave contains the slimy salamander *Plethodon* new species. It was biologically studied on 21 April 1998 and 8 May 1998. Figure 8 Cave is entered by a vertical sinkhole 1.5 m deep. A passage extends about 8 m to the top of an 8.5 m deep pit. A small drain at the bottom is too small to enter (Fig.). The cave contains five endemic species: the blind spiders *Cicurina* (*Cicurella*) sp. and *Neoleptoneta paraconcinna*, the millipede *Speodesmus castellanus*, the ground beetle *Rhadine reyesi*, and the antlike litter beetle *Batrisodes* (*Babnormodes*) *gravesi*. It was biologically studied on 9 February 1996, 24 April 1998, 3 November 1998, and 10 April 2002. Hidden Pit Cave is entered by a 7 m pit, which drops, into a room about 5 by 7 m. Two crawls extend into a joint-guided passage about 17 m long. One end terminates in a 7 m deep pit with a small drain at the bottom too small to follow (Fig.). The cave contains three endemic species: the spider *Neoleptoneta* prob. *paraconcinna*, the pseudoscorpion *Tartarocreagris* prob. *hoodensis*, and the millipede *Speodesmus castellanus*. Biological studies were conducted on 7 August 2003, 18 August 2003, and 14 March 2004. Lucky Rock Cave is entered by a crawlway at the bottom of a 3 m long, 1.5 m wide sinkhole. A slope down to a series of drops to a depth of 14.6 m below the surface (Fig.). The cave contains five endemic species: the spider *Cicurina* (*Cicurella*) sp., the millipede *Speodesmus castellanus*, the ground beetle *Rhadine reyesi*, the antlike litter beetle *Batrisodes* (*Babnormodes*) *gravesi*, and the slimy salamander *Plethodon* new species. Biological studies were conducted on 22 February 1996, 10 September 1997, 25 March 1999, 5 May 1999, and 25 July 2002. Lunch Counter Cave is a 9.5 m long passage at the bottom of a 4.5 m deep sinkhole (Fig.). Biological studies were conducted on 18 September 1997, 25 March 1999, and 10 April 2002. The cave contains the endemic slimy salamander *Plethodon* new species. Peep in the Deep Cave is entered by a pit about 5 m, which opens, into a small chamber. Narrow passages extend for a few meters from the room (Fig.). The cave contains three endemic species: the spiders *Cicurina* (*Cicurella*) *hoodensis* and

Neoleptoneta paraconcinna and the slimy salamander *Plethodon* new species. The cave was biologically investigated on 21 April 1998, 8 May 1998, 3 November 1998, 25 March 1999, 5 May 1999, and 10 April 2002. Seven Cave is a 1.8 by 2.4 m sink that drops to a depth of 2.3 m. The cave contains the slimy salamander *Plethodon* new species. It was biologically investigated on 18 September 1997 and 1 April 1999. Talking Crows Cave contains four entrances, two of which are too small to enter. The cave largely comprises a single room about 5 m below the surface. A narrow crevice and holes in rock continue down to an apparent lower level (Fig.). The cave contains two endemic species: the spider *Cicurina* (*Cicurella*) *hoodensis* and the antlike litter beetle *Batrisodes* (*Babnormodes*) new species. This is the only known locality for the latter species. The cave was studied on 8 February 1996, 20 April 1998, 2 November 1998, 6 June 2000, and 10 April 2002. Treasure Cave is a 3 m diameter sink dropping to a single chamber about 7 m in diameter and 5 m deep (Fig.). The cave was largely excavated by treasure hunters. The cave contains two endemic species: the spider *Cicurina* (*Cicurella*) *hoodensis* and the slimy salamander *Plethodon* new species. It was biologically studied on 14 March 1992, 4 December 1992, 21 April 1998, and 2 November 1998. Valentine Cave is a 4.6 m deep pit that contains a 3 m long passage with drain holes that are too small to enter (Fig.). The cave contains the spider *Cicurina* (*Cicurella*) sp. This is presumably one of the endemic spider species known from the area.

1. Boundaries: This large area could be divided into several smaller overlapping units, but the abundance of sinks and caves throughout the area indicates that most, if not all, of the features are connected at depth through small inaccessible passages that now feed Bear Springs. The boundaries, therefore, are determined to be the plateau edges overlooking Belton Lake on the north and east, then extending along a major drainage to Bear Springs to the northeast, then continuing along a major drainage before circling to the southeast, east, and then northeast. This encompasses all of the known karst features in the area and includes several major drainages presumably important for salamander dispersal (Fig.)

2. Biological research: Adult spiders of the genus *Cicurina* are needed from Figure 8 Cave, Lucky Rock Cave, Peep in the Deep Cave, and Valentine Cave. Specimens of *Speodesmus* are needed from Figure 8 Cave and Lucky Rock Cave. Additional specimens of the antlike litter beetle *Batrisodes* (*Babnormodes*) new species are need from Talking Crows Cave.

3. Fire ants: Fire ants are extremely abundant in some of these caves and present around almost all of them. Their impacts should be eradicated or minimized through appropriate treatment.

4. Training and Administrative Issues. This area is seldom if ever utilized for training purposes. The entire area lies within core habitat for endangered bird species.

Karst Management Area No. 6: Copperhead Cave, Keyhole Cave

Management Area Summary. This area includes two caves containing endemic species and two caves that do not provide habitat for troglobites. Copperhead Cave is a vertical pit that drops 9.75 m into a room about 2.4 m wide and 3 m long. Excavation of fill along the east wall of the entrance led down into a tight passage that extends about 23 m before becoming too narrow (Fig.). It has been gated. The cave is structurally related to Copperhead Cave No.2 a short distance away. The cave contains the endemic millipede *Speodesmus castellanus*. The cave was biologically studied on 30 April 1998. Keyhole Cave contains three drops that reach a depth of 15.3 m below the surface (Fig.). It contains two endemic species: the millipede *Speodesmus castellanus* and the antlike litter beetle *Batrisodes* (*Babnormodes*) *gravesi*. The cave was biologically studied on 20 February 1999 and 6 May 1999. Condescending Cave and Verde Cave are about midway between Keyhole and Copperhead caves but do not contain habitat for endemic species.

1. Boundaries: The groundwater drainage for Copperhead Cave is considered to include an area about 50 m from the footprint of the combined Copperhead Cave and Copperhead Cave No. 2 (Fig.). The groundwater drainage for Keyhole Cave is considered to be an area about 50 m from the footprint of the cave (Fig.). The boundaries of the management area extend 360 m west from Copperhead Cave No. 2 to the edge of a major tank trail and surface drainage divide, then extends southeast about 210 m to a surface drainage divide. It extends to the north for 350 m to the edge of a large firebreak. It extends 270 m east of Keyhole to the drainage of Taylor Branch and about 210 m south of the Keyhole (Fig.). This preserve is contiguous with the Mixmaster Cave management area to the south.

2. Biological research: Adult millipedes of the genus *Speodesmus* are needed from Copperhead Cave.

3. Training and military activities. A major tank trail divides the management area into half, with one half containing Copperhead Cave and the other Keyhole Cave. Most of the preserve areas lie in core endangered bird habitat so that the protected area is effectively much larger.

Karst Management Area No. 7: Mixmaster Cave

Management Area Summary. Mixmaster Cave with 311 m of passage is one of the longer caves on Fort Hood. A sinkhole entrance that had been filled with rocks and trash drops 3.7 m deep to intersect one end of a complex maze of passages that extends about 30 m to a room about 15 m long and 7.5 m wide. The main passage extends from this room as a crawlway for about 60 m before becoming too low. A 4.3 m pit near the end becomes too small. Numerous domes in the first half of the cave extend almost to the surface (Fig.). The entrance is gated. The cave is the only known locality for the spider *Cicurina* (*Cicurella*) *mixmaster*. Other endemic species include the millipede *Speodesmus castellanus* and the antlike litter beetle *Batrisodes* (*Babnormodes*) *gravesi*. The cave was biologically studied on 9 March 1993, 9 September 1997, and 5 November 1998.

1. Boundaries. The cave receives drainage from a large area and the groundwater drainage has not been determined. The boundaries for the management area extend to the north 160 m to a drainage divide; 340 m to the east, 300 m to the south, and 400 m along the trend of the cave to the northwest (Fig.). This encompasses all of the surface drainage into the cave, with additional buffer areas on the south. The management area is contiguous with the Copperhead Cave-Keyhole Cave area to the north.

2. Hydrogeologic delineation. A hydrogeologist should study the cave to determine the groundwater drainage into the cave.

3. Fire ant treatment. The cave and area surrounding it are heavily infested with fire ants. Treatment is required within 50 m of the cave.

4. Training and administrative issues. The upslope area of Mixmaster Cave has been bulldozed clear of all vegetation and is heavily utilized by military personnel. Refueling has been observed in this area. Training activities should be moved from the surface drainage area of the cave and the barren area revegetated.

Karst Management Area No. 8: Monkey Walk Caves No. 1 and 2

Management area Summary. Monkey Walk Cave No. 2 is a 4.3 m deep pit. A small passage connects to Monkey Walk Cave No. 1 through a passage too small for entry (Fig.). The cave contains the slimy salamander *Plethodon* new species. The cave was studied on 23 April 1998.

1. Boundaries. The groundwater drainage for the cave is defined as a 50 m area surrounding the combined footprints of Monkey Walk Caves Nos. 1 and 2. The management area boundaries are based on including the surface drainage areas that probably contain the main habitat for the salamander. The boundary extends 80 m to a heavily disturbed area where five major tank trails converge, then southeast along the tank trail before swinging south until a major drainage is encountered. The boundaries follow the south side of the drainage east before extending about northeast to the tank trail (Fig.).

2. Fire ant treatment. The cave and surrounding area should be treated for fire ants.

3. Training and administrative issues. Barriers should be installed along the tank trails to the northwest and northwest of the cave entrances to prevent accidental damage to the cave entrances. Most of the management lies in core habitat for endangered birds, but the tank trails are heavily used by tracked and other vehicles.

Karst Management Area No. 9: Keilman Cave, Triple J Cave

Management Area Summary. Keilman Cave contains two entrances, one a 3.7 m deep sinkhole and the other a sloping crawlway about 3 m away. The cave continues down but is too small to enter (Fig.). The cave contains the slimy salamander *Plethodon* new species. The cave was biologically studied on 17 November 1994, 26 September 1997, 23 April 1998, 8 May 1998, and 5 June 2000. Triple J Cave is entered by a 2.1 m drop into a sloping passage that extends into a complex area of passages. One of these leads into the main passage of the cave. This passage extends to the southeast for about 20 m and about 15 m to the northwest before it becomes too small in both directions. Two pits drop about 4.8 m to impassable lower levels (Fig.). The cave has been gated. The cave contains four endemic species: the spiders *Cicurina* (*Cicurella*) *caliga* and *C.* (*C.*) *hoodensis,* the ground beetle *Rhadine reyesi*, and the antlike litter beetle *Batrisodes* (*Babnormodes*) *gravesi*. The cave was biologically studied in November 1994, 4 October 1995, 23 April 1998, and 14 June 2000. The management area also encompasses Leaf Mold Sink, String Ball Sink, T.J. Campside Sink, Sink (3A-31), Sink (3A-32), and Sink (3A-34). Of these String Ball Sink appears likely to lead into a cave with excavation.

1. Boundaries: The groundwater drainage for the cave is identified as a 20 m area on the sides of the cave footprint and a 50 m area from both ends of the main trend of the cave (Fig.).

The boundaries of the management are considered to extend 340 m east to encompass String Ball Sink, south 270 m to include a significant drainage area, 260 m north to a disturbed area and tank trail, and west and northwest to the edge of a major tank trail and firebreak (Fig.). The management area is contiguous with the Streak Cave management area to the east.

2. Biological research: Specimens of millipedes of the genus *Speodesmus* and of a possible troglobitic geophilomorph centipede are needed.

3. Training and administrative issues. The cave lies within core endangered bird habitat. The major tank trail and firebreak along the northwest wide of the preserve is sufficiently far from the cave footprints so that there should be no impact from its use

Karst Management Area No. 10: Streak Cave

Management Area Summary. Streak Cave is entered by a 2.4 m diameter sink that drops into a passage that slopes to a 4.9 m deep pit. One passage from the bottom extends 7.6 m towards Copperhead Sink before becoming too small. The other extends a total of about 16 m before ending at a dome. Drainage holes in the floor indicate that a lower level exists (Fig.). The cave contains four endemic species: the spider *Cicurina* (*Cicurella*) sp., the millipede *Speodesmus castellanus*, the ground beetle *Rhadine reyesi*, and the antlike litter beetle *Batrisodes* (*Babnormodes*) *gravesi*. The cave was biologically studied on 6 October 1995, 26 September 1997, and 14 June 2000.

1. Boundaries. The groundwater drainage is interpreted as being about 20 m on both sides of the cave footprint and 100 m along the main trend of the cave. The boundaries of the management area extend 185 m to the west where it intersects the Keilman Cave-Triple J Cave management area, 320 m south, 360 m north to a main tank trail, and 260 m northeast to a major drainage.

2. Biological research. Additional specimens of *Speodesmus* millipede and blind *Cicurina* spider are needed.

3. Training and administrative issues. There is no or essentially no training in this area which is located entirely in core habitat for endangered bird species.

Karst Management Area No. 11: Cowbell Cave, Fellers Cave, Rainy Day Cave

Management Area Summary. The entrance to Cowbell Cave is a pit about 2 m wide, 2 m deep, and 13.4 m deep. The pit continues to drop but will require enlargement to enter (Fig.). The cave contains the slimy salamander *Plethodon* new species. It was investigated on 22 January 2004. Fellers Cave is a vertical 7 m pit. This drops to a sloping floor of breakdown that leads to a 2 m drop. The pit continues down at least 3 m but will require enlargement to enter (Fig.). The cave is gated. The cave contains three endemic species: the spider *Cicurina* (*Cicurella*) sp., the millipede *Speodesmus castellanus* and the ground beetle *Rhadine reyesi*. It was studied on 4 December 1992, 6 May 1998, and 20 February 2002. Rainy Day Cave is a pit about 7 m deep that is plugged with rocks and sediment (Fig.). It contains the endemic millipede *Speodesmus castellanus* and the slimy salamander *Plethodon* new species. The cave was studied on 14 August 2003 and 14 February 2004. The management area also includes Craggy Rock Cave, which does not contain endemic species, and several sinks.

1. Boundaries: The groundwater drainage for each cave is considered to be 50 m from the footprint of the cave. The management area extends north 200 m to the edge of the plateau, east 280 m from the entrance of Fellers Cave, 320 m south of the entrance of Rainy Day Cave, and 300 m west of the entrance of Cowbell Cave (Fig.).

2. Biological research: Additional specimens of spider of the genus *Cicurina* and millipedes of the genus *Speodesmus* are needed.

3. Training and administrative issues. The entire management area is in core habitat for endangered bird species. There is little or no training in this area.

Karst Management Area No. 12: Owl Mountain Cave

Management Area Summary. The entrance to Owl Mountain Cave is a body-sized opening that drops 2.4 m into a crawlway that becomes too small after about 12 m (Fig.). The cave contains the blind spider *Cicurina* (*Cicurella*) sp. It was biologically studied on 24-25 October 1995, 28 May 2000, 27 June 2000, and 9 April 2002. The management area also includes Falling Water Shelter Cave on the bluffs overlooking Owl Creek, and two sinks.

1. Boundaries: The groundwater drainage for the cave is considered to be 20 m along the side and 30 m from the ends of the cave passage. The boundaries of the management area are 240 m north and then along the edge of the plateau (the Fort Hood boundary line), 300 m east, 280 m south, and 340 m west.

2. Biological research: Additional specimens of spider of the genus *Cicurina* are needed.

3. Training and administrative issues. There is little or no training in this area. It lies entirely within core habitat for endangered bird species.

Karst Management Area No. 13: Bumelia Well Cave, Rugger's Rift Cave

Management Area Summary. Bumelia Well Cave is a pit complex that attains a total depth of 27.49 m, making it the deepest cave on Fort Hood. A tight passage extends about 12 m from the bottom before becoming too small. It periodically contains pools of water containing stygobitic crustaceans (Fig.). The cave contains three endemic species: the millipede *Speodesmus castellanus*, the ground beetle *Rhadine reyesi,* and the antlike litter beetle *Batrisodes* (*Babnormodes*) *gravesi.* It was studied on 28 October 1994 and 5 November 1998. Rugger's Rift Cave contains four entrances, one of which is plugged. The main entrance is at the bottom of a large sinkhole and leads into a crawlway that passes beneath 6.1 and 9.85 m deep entrances before terminating in a large pit. This pit drops 9.1 m to a rock floor. A complex of additional pits leads down to a depth of 27.25 m below the surface, making it the second deepest cave on Fort Hood (Fig.). The cave contains three endemic species: the spider *Cicurina* (*Cicurella*) sp., the pseudoscorpion *Tartarocreagris hoodensis,* and the antlike litter beetle *Batrisodes* (*Babnormodes*) *gravesi*. The cave was studied on 5 November 1998. Two other caves and three sinks occur in the management area but do not contain endemic species.

1. Boundaries. The boundaries for this area extend 330 m to the north, 300 m to the west, and 300 m to the south of Rugger's Rift Cave; and 330 m east of Bumelia Well Cave. A pipeline and corresponding road cut through the area a short distance west of Rugger's Rift Cave. This management area overlaps that of Newby Cave to the north.

2. Biological research. Additional specimens of blind spider of the genus *Cicurina* are needed from Rugger's Rift Cave.

3. Training and administrative issues. There is little or no training in this area, which lies entirely within core habitat for endangered birds.

Karst Management Area No. 14. Newby Cave

Management Area Summary. Newby Cave is a 0.6 m by 1.2 m pit that drops about 7 m to fill (Fig.). The cave contains the slimy salamander *Plethodon* new species. The cave was biologically investigated on 19 May 1999 and 12 November 2002.

1. Boundaries. The groundwater drainage for the cave is considered to be 20 m around the footprint of the cave (Fig.). The management area boundaries extends north about 400 m to the floor of Bear Valley, 350 m northeast to the far side of a major drainage, south 330 m to encompass the headwaters of two drainages, and east 380 m. The management area overlaps that of the Bumelia Well Cave-Rugger's Rift Cave area.

2. Fire ant treatment. Fire ant treatment should be conducted within 50 m of the cave entrance.

3. Training and administrative issues. The preserve area lies within core habitat for endangered birds.

Karst Management Area No. 15: Violet Cave

Management Area Summary. The entrance to Violet Cave is a 3.2 m deep pit in a large depression. Tight squeezes lead back into a complex area with about 20 m of passage (Fig.). The cave contains the slimy salamander *Plethodon* new species. It was studied in October 1995, 23 April 1998, and 5 June 2000.

1. Boundaries: The groundwater drainage for the cave is considered to be an area about 50 m from the footprint of the cave. The management areas extend 350 m south to Bear Valley, 240 m east to a major tank trail, 320 m west to the far side of a drainage, and 170 m north to a major tank trail.

2. Training and administrative issues. The management area is entirely within core habitat for endangered birds.

Karst Management Area No. 16: Sanford Pit Cave

Management Area Summary. The entrance is a 7.6 m pit that leads after 6 m to a 11.6 m deep blind pit. The cave contains three endemic species: the spider *Cicurina* (*Cicurella* sp., the millipede *Speodesmus castellanus*, and the ground beetle *Rhadine reyesi*. The cave was biologically studied on 23 November 1994, 18 May 1998, and 4 November 1998. Keebler Cave and four sinks also occur in the management area

1. Boundaries: The groundwater drainage for the cave is considered to be a 50 m area to the south, north, and west of the cave, and to extend to 20 m east of Keebler Sink (Fig.). The management area boundaries extend 270 m west to Bull Branch, 300 m north, and 320 m to the south and east of the cave entrance (Fig.)

2. Biological research: Additional specimens of spider of the genus *Cicurina* and millipedes of the genus *Speodesmus* are needed.

3. Training and administrative issues. The management area is entirely within core habitat for endangered birds.

Karst Management Area No. 17: Price Pit Cave

Management Area Summary. Price Pit Cave is a single room about 3.7 m wide and 4.6 m long at the bottom of a 12 m deep pit (Fig.). The cave contains two endemic species: the millipede *Speodesmus castellanus* and the antlike litter beetle *Batrisodes* (*Excavodes*) *gravesi*. The cave was biologically studied on 23 March 1999 and 6 May 1999.

1. Boundaries: The groundwater drainage for this cave is considered to be 20 m on all sides of the entrance (Fig.). The management area boundaries extend for 200 m north to a major tank trail, 340 m to the east, 270 m south to a firebreak, and 260 m west to a heavily disturbed area (Fig.). The tank trail crossing the area to the south of the cave entrance is not desirable but the surrounding area is endangered bird habitat; therefore, the effective protected area is significantly greater than that considered management area.

2. Fire ant treatment. The cave should be treated within 50 m of the cave entrance for fire ants.

3. Training and administrative issues. The management area lies within core habitat for endangered birds.

Karst Management Area No. 18: Skeeter Cave

Management Area Summary. Skeeter Cave is a pit that drops 5.5 m to a slope of loose rocks and sediment (Fig.). The cave is the only known locality for the antlike litter beetle *Batrisodes* (*Babnormodes*) *feminiclypeus*. The cave was biologically studied on 18 May 1999 and 9 April 2002. A second recently discovered cave, Born Again Cave, may contain the same species of beetle but the sole specimen seen could not be captured. Several caves and sinkholes have been recently discovered to the south and southwest of Skeeter Cave and may be included in the management area with further study.

1. Boundaries: The groundwater drainage for the cave includes a 20 m area to the north, east, and west. It should be extended to the south to include several small sinks and Born Again Cave (Fig.). The boundaries of the management area are tentatively defined as 130 m north to a major drainage, 170 m east to a major drainage, 310 m west, and 300 m south of Born Again Cave (Fig.).

2. Cave delineation: Airflow from the cave indicates that removal of loose rocks and sediment from the floor of the cave will lead to additional passage. An attempt to excavate the cave should be made to allow a better determination of the extent of the cave. Born Again Cave needs to be surveyed.

3. Biological research. Born Again Cave should be biologically studied.

4. Training and administrative issues. There is little or no training in this area and it lies entirely within core habitat for endangered birds.

Karst Management Area No. 19: Estes Cave

Management Area Summary. Estes Cave is a 15 m deep pit (Fig.). The cave contains the slimy salamander *Plethodon* new species. The cave was biologically studied on 28 June 2000 and 21 February 2002.

1. Boundaries: The groundwater drainage for this cave are considered to be an area of 20 m on all sides of the entrance. The boundaries of the management area extend 340 m north to the far side of Bear Creek, 300 m east to the far side of a major drainage, 280 m south-southwest to the head of a drainage, and 310 m to the east (Fig.).

2. Training and administrative issues. The area is an area of little or no training and lies entirely within core habitat for endangered birds.

Karst Management Area No. 20-: Moffat Pit Cave

Management Area Summary. Moffat Pit Cave is a 4.6 m long, 1.8 m wide pit that drops a total of 12.3 m to sediment (Fig.). The cave contains the slimy salamander *Plethodon* new species. It was studied in October 1995 and on 1 May 1998. A second cave, Septum Pit Cave and one small sinkhole lie within the management area but do not contain endemic species.

1. Boundaries: The groundwater drainage for this cave are determined to be about 30 m on all sides of the entrance. The management area boundaries extend 130 m north to the north side of a drainage, 250 m to the west, 140 m south to the south side of a drainage, and 300 m east along a major drainage (Fig.)

2. Training and administrative issues. There is little or no training in this area and the management area lies entirely within core habitat for endangered birds.

Karst Management Area No. 21: Lucky Day Cave

Management Area Summary. Lucky Day Cave is a sinkhole that descends in a series of drops to a depth of about 16 m where a joint-guided passage extends a few meters in both directions (Fig.). The cave contains the antlike litter beetle *Batrisodes* (*Babnormodes*) sp. The cave was biologically studied on 3-4 June 2003 and 4 March 2004. One other cave, Dionne Cave, and two sinks also occur in the management area but do not contain endemic species.

1. Boundaries. The groundwater drainage area for the cave is considered to extend 50 m from the east and north ends of the cave and 20 m along the sides. The boundaries of the management area extend 220 m north from Dionne Cave to a major tank trail, 225 m west of Dionne Cave to the edge of a major drainage, 280 m south of Dionne to the head of a drainage, and 250 m east of Lucky Day Cave (Fig.).

2. Biological research. The cave should be more thoroughly biologically investigated.

3. Training and administrative issues. The management area lies entirely within core habitat for endangered birds.

Karst Management Area No. 22: West Corral Cave No. 4

Management Area Summary. West Corral Cave No. 4 is one of four caves that are structurally connected but it is not possible to humanly pass from one to the other. Cave No. 4 is a 3.3 m deep pit. West Corral Cave No. 1, however, reaches a depth of about 15 m (Fig.). The cave contains the pseudoscorpion *Tartarocreagris ?hoodensis*. It was biologically studied on 10 May 2003 and 24 June 2003. The management area also includes Corkscrew Cave and two small sinks.

1. Boundaries. The groundwater drainage is considered to be an area 20 m on each side of the complex of four caves (Fig.). The boundaries of the management area extend 300 m east, then north to Bull Branch and north along Bull Branch to a point about 300 m from the cave entrance, and 300 m to the west and south of the cave.

2. Biological research. The four West Corral Caves and Corkscrew Cave need to be more adequately sampled during good weather conditions.

3. Training and administrative issues. The management area lies entirely within core habitat for endangered birds.

North Fort Hood Karst Fauna Region: Rocket River Cave Subregion

Karst Management Area No. 23: Rocket River Cave System

Management Area Summary. The Rocket River Cave System as considered here consists of several caves that appear to be hydrologically related but have not yet been physically connected. The Rocket River Cave System proper is a 2571 m long and 16.4 m deep. It includes three sinkhole entrances (B.R.'s Secret Cave, Rocket River Cave, and Doubletree Cave) and two spring entrances (Cave Springs Cave and Flowstone Spring Cave). The cave contains an active stream (Fig.). 1923 Cave is 173 m long contains a stream passage that probably connects to upstream Rocket River Cave (Fig.). Briar Cave has been surveyed for 137 m and contains an active stream (Fig.). The cave is clearly hydrologically related to Plateau Cave No. 1. Plateau Cave No. 1 is a major recharge feature that ends in very low airspace but once probably connected to Rocket River Cave (Fig.). Plateau Cave No. 2 is a single chamber about 9 m deep. A small hole in the floor is connected to Briar Cave but is too small for human entry. (Fig.). Wagontop Cave and Wagontop Cave Spring are likely the downstream outlets for the Briar-Plateau segment of the system (Fig.). The only cave in the system known to contain endemic species is Rocket River Cave. It contains four endemics: the spider *Cicurina* (*Cicurella*) sp., the millipede *Speodesmus castellanus*, the antlike litter beetle *Batrisodes* (*Babnormodes*) *wartoni*, and the slimy salamander

Plethodon new species. The Rocket River Cave section of the system was studied on 14 January 1992, 16 January 1992, 16 July 1993, 27 October 1994, and 17 September 1997.

1. Boundaries: The groundwater drainage area is considered to be basically the same as the preserve boundaries. These boundaries extend 300 m south of Rocket River Cave, east and west to the edges of the plateau, and 300 m north of Plateau Cave No. 2 (Fig.).

2. Biological research: Specimens of salamander (presumably *Plethodon* new species) should be obtained from the Rocket River Cave System. Further studies in the Rocket River Cave System and other caves in the area should be conducted to determine if additional species of concern occur in them.

3. Cave and hydrogeologic delineation: The hydrogeology of the caves remains poorly understood. Attempts to explore and map 1923 Cave and Briar Cave should be made to determine their relationship to the other caves in the area. If these are unsuccessful dye tracing should be employed to determine flow paths in the caves of the area.

4. Road near Plateau Cave No. 1: The road crossing the drainage of Plateau Cave No. 1 should be modified to allow more natural drainage into the cave.

5. Training and administrative issues. This area is in a live fire zone and receives little ground visitation. There is no evidence that the present level of activity is harmful to the cave fauna.

Karst Management Area No. 24: Tippit Cave

Management Area Summary. The entrance to Tippit Cave is a sinkhole that drops 1 m to a slope that extends down to a pit that drops into a horizontal passage extending about 9 m to the west before becoming too small. The passage extends to the east for a total of about 43 m. A pit in the floor of this passage drops 3 m to a lower level passage with a stream containing stygobitic crustaceans (Fig.). The cave contains four endemic species: the spider *Cicurina* (*Cicurella*) *wartoni*, the millipede *Speodesmus castellanus*, the ground beetle *Rhadine reyesi*, and the antlike litter beetle *Batrisodes* (*Babnormodes*) *wartoni*. The cave was biologically studied on 9 March 1963, 24 January 1992, 31 January 1992, 9 February 1992, 27 February 1992, 3 November 1992, 4 November 1992, 6 November 1992, 16 July 1993, 22 April 1998, and 8 April 1999.

1. Boundaries. The boundaries for the management area extend 90 m to the east to the edge of the plateau, 250 m south, 317 m north to the edge of the plateau, and 300 m west. This area overlaps with the Rocket River Cave System area to the south.

2. Bats. The cave once contained a significant bat colony. Vegetation around the entrance should be cleared to determine if bats will once again colonize the cave.

3. Management and administrative issues. The cave is in a live fire area. There is little ground traffic and there is no evidence that the present level of activity has harmed the cave or its fauna.

North Fort Hood Karst Fauna Region: Egypt Hollow Subregion

Karst Management Area No. 25: Chigiouxs' Cave, Cornelius Cave

Management Area Summary. Chigiouxs' Cave is entered through a sinkhole that descends to a depth of about 7 m below the surface. The cave consists of a series of small passages and rooms for about 15 m (Fig.). The cave contains the pseudoscorpion *Tartarocreagris hoodensis* and the antlike litter beetle *Batrisodes* (*Babnormodes*) *wartoni.* It was studied on 22 November 1994 and 21 November 1995. Cornelius Cave is entered by a sinkhole that drops 3.4 m into a passage. The main passage extends to the east for about 10 m before ending (Fig.). The cave contains the millipede *Speodesmus castellanus*. The cave was biologically studied on 21 November 1995.

1. Boundaries: The boundaries of the management area extend for 300 m east of Cornelius Cave and 300 m south, west, and north of Chigiouxs' Cave (Fig.).

2. Biological research: Additional specimens of *Speodesmus* are needed from Cornelius and Ingram caves to verify the taxonomic status of the species in those caves. Egypt Cave should continue to be monitored for bat usage. Missing History Cave should be studied to determine if it contains species of concern.

3. Management and administrative issues. The cave is in a live fire area. There is little ground traffic and there is no evidence that the present level of activity has harmed the cave or its fauna.

Karst Management Area No. 23: Egypt Cave, Ingram Cave

Management Area Summary. Egypt Cave contains two sinkhole entrances. The largest is an opening about 4.6 m deep that intersects a passage extending back to the ESE to the second entrance. The cave consists of several parallel and subparallel intersecting passages with a total of 124 m length (Fig.). The cave contains the spider *Cicurina* (*Cicurella*) *coryelli.* It was biologically studied on 13 January 1992, 21 January 1992, 23 November 1994, 16 September 1997, and 8 April 1999. Ingram Cave is entered by a 6.4 m deep sink. A slope from the bottom extends to a second pit that drops to a depth of 12.5 m below the surface (Fig.). The cave contains the millipede *Speodesmus* new species. The cave was investigated on 16 September 1997 and 7 April 1998. Two other caves, Missing History Cave and Porter Cave, occur in the management area. Porter Cave does not contain habitat for endemic species but Missing History Cave has not been biologically investigated.

1. Boundaries. The boundaries for this management area are considered to be 300 m east and south of Ingram Cave, 300 m north of Egypt Cave and 290 m northeast of Egypt Cave (Fig.).

2. Biological research. Missing History Cave should be biologically investigated. Debris clogged in the entrance shaft need to be removed to allow safe entry.

3. Bats. Egypt Cave once housed a significant bat colony. Vegetation should be removed from around the entrance to see if bat will return.

4. Training and administrative issues. The caves are in a live fire area and there is little ground activity. There is no evidence that the present level of activity has harmed the caves or their fauna.

Management Plan Implementation Schedule

The implementation schedule in Table 7 follows the actions outlined for the management plan; specific management actions for the karst fauna areas are addressed under task 4. The schedule is intended as a guide for meeting the plan's objectives. It prioritizes task importance based on the species' needs, which may be direct, such as mitigating a threat, or indirect, such as understanding their needs through research. The priorities for each task are in agreement with USFWS (1994) priorities for recovery of related karst invertebrates in Travis and Williamson counties, Texas. Priorities in the first column of Table 7 are defined per those of the USFWS (1994):

Priority 1: An action that must be taken to prevent extinction or to prevent the species from irreversibly declining in the foreseeable future.

Priority 1•: An action that by itself will not prevent extinction, but which is needed to carry out a priority 1 task.

Priority 2: An action that must be taken to prevent a significant decline in species population/habitat quality, or some other significant negative impact short of extinction.

Priority 3: All other actions necessary to meet the recovery objectives.

Table 7

**MANAGEMENT PLAN:
IMPLEMENTATION PRIORITY AND SCHEDULE**

Priority number	Task number	Task Description	Task duration (years)
1	1.	Identify karst fauna areas needed to meet the management plan criteria.	<1
1	2.	Determine the appropriate size and shape of the karst fauna areas targeted for management.	1-2
1	3.	Provide protection in perpetuity to targeted karst fauna areas.	ongoing
1	3.1	Coordinate with USFWS, TPWD, and other agencies.	1 initially, then ongoing
1	3.2	Review and update Fort Hood regulations as needed.	ongoing

1	4.	Implement conservation measures and manage targeted karst fauna areas.	ongoing
1	4.1	Apply USFWS fire ant management techniques.	ongoing
1	4.2	Identify and protect important sources of nutrients into karst ecosystems.	1-2
1	4.3	Determine and implement appropriate means to prevent vandalism, dumping of trash, and unauthorized human entry.	ongoing
1•	4.4	Other actions as needed.	ongoing
1•	5.2	Continue hydrogeologic studies of karst fauna areas that are currently incomplete.	1-3
1•	5.4	Review the karst species management plan.	3-5
2	6.1	Develop educational programs to raise awareness and encourage protection of karst ecosystems by Fort Hood personnel.	1
2	6.2	Develop educational programs on karst ecology and hydrogeology to help key Fort Hood personnel with the management of the karst fauna areas and the species of concern.	1
2	6.3	Develop educational information for public relations.	1
2	7.	Monitoring	ongoing
3	5.1	Conduct additional karst and biospeleological surveys.	6-10
3	5.3	Conduct additional studies on the ecology of the species of concern.	8-12

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APPENDIX A
Glossary of Geologic, Karst, and Biological, Terminology

This glossary is broad in scope to assist nonspecialists reviewing this report, but is not meant to cover all possible terms. Additional karst definitions and geologic terms can be found in the geologic dictionary of Jackson (1997); for biospeleological terms see Culver (1982).

Accidental: A species of animal that normally does not normally occur in caves, but has fallen, wandered, been washed or carried into a cave; not a part of the true cave fauna but may be an important food source for cavernicoles.

Alluvium: Stream-deposited sediments, usually restricted to channels, floodplains, and alluvial fans.

Anastomoses: Small interconnecting conduits that fork and rejoin, usually along bedding planes and joints.

Aquiclude: Rocks or sediments, such as shale or clay, which do not conduct water in significant quantities.

Aquifer: Rocks or sediments, such as cavernous limestone and unconsolidated sand, which store, conduct, and yield water in significant quantities for human use.

Aquitard: Rocks or sediments, such as cemented sandstone or marly limestone, that transmit water significantly more slowly than adjacent aquifers and that yield at low rates.

Artesian: Describes water that would rise above the top of an aquifer if intersected by a well; sometimes flows at the surface through natural openings such as fractures.

Arthropod: An animal of the Phylum Arthropoda; member species are invertebrate, have segmented bodies and jointed legs, and include animals such as insects, crustaceans, and arachnids.

Attitude: The position of a bed of rock with respect to the horizontal plane; typically measured as strike and dip.

Base level: The level to which drainage gradients (surface and subsurface) are adjusted, usually a surface stream, relatively impermeable bedrock, or water table. Sea level is the ultimate base level.

Baseflow: The “normal” discharge of stream when unaffected by surface runoff; derived from groundwater flowing into the stream channel.

Bearing: The azimuthal direction of a linear geologic feature, such as the axis of a fold or the orientation of a fracture; commonly used to denote specific orientations rather than average or general orientations. See trend for comparison.

Beds: See strata.

Bedding plane: A plane that divides two distinct bedrock layers.

Borehole: A drilled hole, commonly used for fluid or mineral extraction and injection, or for the monitoring or testing of geologic parameters.

Breakdown: Rubble and boulders in a cave resulting from collapse of the cave ceiling.

Breccia: A rock composed of broken, angular fragments of a pre-existing rock that were cemented to form the present rock unit.

Calcite: The predominant mineral in limestone. It is relatively soluble compared to other common minerals, and allows for the dissolution of limestone and the precipitation of calcite speleothems.

Carbonate aquifer: An aquifer developed in predominantly carbonate rock, usually limestone or dolomite.

Cave: A naturally occurring, humanly enterable cavity in the earth, at least 5 m in length and/or depth, in which no dimension of the entrance exceeds the length or depth of the cavity (definition of the Texas Speleological Survey).

Cavernicole: A species of animal that spends at least part of its life cycle in the subterranean environment.

Chamber: See room.

Chelae: The pincer-like claw of a scorpion's of pseudoscorpion's pedipalp.

Chelicerae: The first pair of appendages in front of the mouth of an arachnid; used for grasping and cutting food, and usually claw-like.

Chert: A microcrystalline silica rock, often found as nodules or small lens in limestone and dolomite; it is essentially the same as "flint."

Conduit: A subsurface bedrock channel formed by groundwater solution to transmit groundwater; often synonymous with cave and passage, but generally refers to channels either too small for human entry, or of explorable size but inaccessible. When used to describe a type of cave, it refers to base level passages that were formed to transmit groundwater from the influent, upgradient end of the aquifer to the effluent, downgradient end.

Conduit flow: Groundwater movement along conduits; usually rapid and turbulent.

Conduit groundwater divide: Where the baseflow of a cave passage splits to flow downstream in two different conduits, and often to two different destinations. Divides can occur both above and below the water table.

Confined: Pertaining to aquifers with groundwater restricted to permeable strata that are situated between impermeable strata.

Cretaceous: A period of the geologic time scale that began 135 million years ago and ended 65 million years ago.

Depth: In relation to the dimensions of a cave or karst feature, it refers to the vertical distance from the elevation of the entrance of the cave or feature to the elevation of its lowest point. See vertical extent for comparison.

Dip: The angle that joints, faults or beds of rock make with the horizontal; colloquially described as the "slope" of the fractures or beds. "Updip" and "downdip" refer to direction or movement relative to that slope.

Diffuse flow: Laminar and very slow groundwater movement within small voids of primary and secondary porosity, excluding conduit and fissure flow; "intergranular" flow.

Discharge: The water exiting an aquifer, usually through springs or wells; also the amount of water flowing in a stream.

Downdip: See dip.

Drainage basin: A watershed; the area from which a stream, spring, or conduit derives its water.

Drainage divide: Location where water diverges into different streams or watersheds. On the surface they usually occur along ridges or elevated areas. In aquifers, they occur along highs in the potentiometric surface between groundwater basins.

Dye trace: The injection of a non-toxic dye into a groundwater system, and its recovery at a downgradient location (usually a spring). This technique is commonly used in karst areas to define groundwater flow paths and travel times.

Ecotone: A transitional zone between ecological communities; usually contains species representation of each community.

Elytra: The hardened front wings in beetles that cover and protect the delicate hind wings when the insect is not flying.

Endemic: Biologically, refers to an organism that only occurs within a particular locale.

Endogean: Pertaining to species living beneath the surface of the earth, although not necessarily in a cave.

Epigean: Pertaining to species living on the surface of the earth.

Epikarst: The highly solutioned zone in karst areas between the land surface and the predominantly unweathered bedrock.

Fault: Fracture in bedrock along which one side has moved with respect to the other.

Floodplain: The flat surface that is adjacent and slightly higher in elevation to a stream channel, and which floods periodically when the stream overflows its banks.

Footprint: The outline of the cave in plan view; generally refers to defining the horizontal limits of the cave as they relate to the land surface.

Fracture: A break in bedrock that is not distinguished as to the type of break (usually a fault or joint).

Geomorphology: The branch of geology that studies the shape and origin of landforms.

Gouge: The finely ground material that forms along some fault planes by the grinding of one plane against the other.

Grade: The continuous descending profile of a stream; graded streams are stable and at equilibrium, allowing transport of sediments while providing relatively equal erosion and sedimentation. A graded profile generally has a steep slope in its upper reaches and a low slope in its lower reaches.

Head: The difference in water level elevations that creates the pressure for water movement down a gradient.

Headward: In the direction of greater elevation; typically refers to upstream or up a hydraulic gradient.

Historic: One of four temporal/technological periods recognized by archeologists for the central Texas region. It is generally recognized as the beginning of permanent European and/or American contact and settlement up to the mid-20th century.

Holotype: The primary specimen selected as representative of a species by the taxonomist who described the species. The specimen must be reposited in a scientific collection and available for study by qualified scientists.

Honeycomb: An interconnected series of small voids in rock, commonly formed in karst by near-surface (epikarstic) solution, or by phreatic groundwater flow.

Hydrogeology: The study of water movement through the earth, and the geologic factors that affect it.

Hydrograph: A graph illustrating changes in water level or discharge over time.

Hydrology: The study of water and its origin and movement in atmosphere, surface, and subsurface.

Impermeable: Does not allow the significant transmission of fluids.

Interstitial zone: Conduits of an aquifer and/or cave that are too small for human access; can be located both above and below the water table. Generally used to describe a type of habitat for cavernicole fauna. May include inferred conduits of probable humanly passable dimensions, but which are inaccessible for study.

Joint: Fracture in bedrock exhibiting little or no relative movement of the two sides.

Karren: Furrows, pits, steps, and other solutional features found on exposed limestone outcrops; each feature is general only a few millimeters or centimeters in size, although meter-scale features are not uncommon in certain settings.

Karst: A terrane characterized by landforms and subsurface features, such as sinkholes and caves, which are produced by solution of bedrock. Karst areas commonly have few surface streams; most water moves through cavities underground.

Karst feature: Generally, a geologic feature formed directly or indirectly by solution, including caves; often used to describe features that are not large enough to be considered caves, but have some probable relation to subsurface drainage or groundwater movement. These features typically include but are not limited to sinkholes, enlarged fractures, noncavernous springs and seeps, soil pipes, and epikarstic solution cavities.

Knickpoint: An interruption or break in the slope of a stream. Often associated with changes in lithology, stream discharge, or base level.

Laminar flow: Smooth water movement along relatively straight paths, parallel to the channel walls.

Length: In relation to the dimensions of a cave or karst feature, it refers to the summed true horizontal extent of the cave's passages or the feature's extent.

Lineament: A linear feature, usually observed in aerial photographs, which likely represents a geologic feature such as a fault, joint, or lithologic contact.

Lineation: A linear alignment of features that may indicate control by fractures or other geologic features or processes.

Lithology: The description or physical characteristics of a rock.

Marl: Rock composed of a predominant mixture of clay and limestone.

Nodular: Composed of nodules (rounded mineral aggregates).

Normal fault: A fault where strata underlying the fault plane are higher in elevation than the same strata on the other side fault plane.

n. sp.: Taxonomic abbreviation for "new species;" used when a species name has not been assigned.

Paleodrainage: An earlier pattern or condition of surface or groundwater flow.

Paleokarst: A karst area that has been buried by sediments that may also fill the existing caves.

Paleospring: A once-active spring that no longer discharges groundwater, usually because the water table has lowered, or because it has been truncated from its recharge zone.

Palpal: Refers to the pedipalps.

Passage: An elongate, roofed portion of a cave or karst feature; usually a conduit for groundwater flow.

Pedipalps: The second pair of appendages at the mouth of arachnids, the bases of which provide a jaw-like function; they provide a grasping or pinching function for handling food.

Perched groundwater: Relatively small body of groundwater at a level above the water table; downward flow is impeded within the area, usually by impermeable strata.

Permeable: Allows the significant transmission of fluids.

Permeability: Measure of the ability of rocks or sediments to transmit fluids.

Phreatic: The area below the water table, where all voids are normally filled with water.

Piracy: The natural capture of water from a watershed, stream, aquifer, or cave stream, and its transmission to a different watershed, stream, aquifer, or cave stream.

Pit: A vertical cavity extending down into the bedrock; usually a site for recharge, but sometimes associated with collapse.

Pleistocene: An epoch of the Quaternary Period of the geologic time scale that began 2 million years ago and ended about 10,000 years ago. Colloquially called the "Ice Age" due to its episodes of continental glaciation.

Porosity: Measure of the volume of pore space in rocks or sediments as a percentage of the total rock or sediment volume.

Potentiometric surface: A surface representing the level to which underground water confined in pores and conduits would rise if intersected by a borehole. See water table.

Pronotum: In insects, the upper (dorsal) side of the front (anterior) part of the thorax; in *Rhadine* beetles it is elongated like a neck.

Reach: The length of a stream or stream segment; often used to denote similar physical characteristics.

Recent: A term often used by archeologists to describe cultural materials or artifacts dating from the mid-20th century to the present.

Recharge: Natural or artificially induced flow of surface water to an aquifer.

Room: An exceptionally wide portion of a cave, often at the junction of passages; commonly indicative of either the confluence of groundwater flowpaths or of slow, nearly ponded, groundwater flow. Generally synonymous with chamber, except that chamber is usually reserved for relatively large rooms.

Seep: A spring that discharges a relatively minute amount of groundwater to the surface at a relatively slow rate; typically a “trickle.”

Setae: Hairs on invertebrates.

Shaft: See pit.

Sheetwash: Surface water runoff that is not confined to channels but moves across broad, relatively smooth surfaces as thin sheets of water.

Sink: See sinkhole.

Sinkhole: A natural indentation in the earth's surface related to solutional processes, including features formed by concave solution of the bedrock, and/or by collapse or subsidence of bedrock or soil into underlying solutionally formed cavities.

Sinking stream: A stream that losses all or part of its flow into aquifer. See swallet.

Solution: The process of dissolving; dissolution.

sp.: Taxonomic abbreviation for “species;” when following a genus name, it indicates lack of identification to species level. Plural is spp.

Speleothem: A chemically precipitated secondary mineral deposit (e.g., stalactites and stalagmites) in a cave; usually calcite but can form from gypsum and other minerals.

Spermathecae: Sacs used for sperm storage in female invertebrates.

Spring: Discrete point or opening from which groundwater flows to the surface; strictly speaking, a return to the surface of water that had gone underground.

Stage: The water level elevation or height measured in a stream or a well.

Strata: Layers of sedimentary rocks; usually visually distinguishable. Often called beds. The plural of stratum.

Stratigraphic: Pertaining to the characteristics of a unit of rock or sediment.

Stratigraphy: Pertaining to or the study of rock and sediment strata, their composition and sequence of deposition.

Strike: The direction of a horizontal line on a fracture surface or on a bed of rock; perpendicular to dip.

Structure: The study of and pertaining to the attitude and deformation of rock masses. Attitude is commonly measured by strike and dip; deformational features commonly include folds, joints, and faults.

Stump hole: A depression that resembles a sinkhole, but is formed by tree growth and is present after the tree has rotted away; often maintains a sinkhole-like appearance by burrowing mammals.

Stygobite: An aquatic species of animal that is restricted to underground waters and exhibits characters such as depigmentation, loss of eyes, and elongate appendages.

Taxa: Taxonomic categories, such as species, genus, etc.; taxon is a singular category.

Taxonomy: A system for classifying organisms into related groups and in descending order.

Tergite: The upper plate of an arthropod's abdominal segment.

Terrace: A relatively narrow, flat topographic surface; with reference to streams it usually marks the elevation of a form, higher, water level, and is composed of and formed by the deposition of unconsolidated sand, gravel, and related material.

Tibia: In arthropods, the fourth joint of a leg.

Trend: The azimuthal direction of a linear geologic feature, such as the axis of a fold or the orientation of a fracture; commonly used to denote average or general orientations rather than specific orientations.

Trochanter: In arthropods, the second joint of a leg.

Troglobite: A species of animal that is restricted to the subterranean environment and which typically exhibits morphological adaptations to that environment, such as elongated appendages and loss or reduction of eyes and pigment.

Troglophile: A species of animal that may complete its life cycle in the subterranean environment but which may also be found on the surface.

Trogloxene: A species of animal that inhabits caves but which must return to the surface for food or other necessities.

Type locality: The location or area from which a species is first found and described, or where a section or unit of bedrock is described as the typical example; more commonly called type area or type section when used in a geologic context.

Unconfined: Pertaining to aquifers having no significant impermeable strata between the water table and the land surface.

Updip: See dip.

Vadose: Pertaining to the zone above the water table where all cavities are generally air-filled, except during temporary flooding.

Vertical extent: In relation to the dimensions of a cave, refers to the vertical distance from the highest elevation to the lowest elevation of the cave. Generally used when a portion of a cave extends above its entrance. See depth for comparison.

Vug: A small cavity in rock, often lined with crystals, and generally not significantly related to groundwater movement.

Water table: The boundary of the phreatic and vadose zones. A potentiometric surface but the term is used only in unconfined aquifers.

APPENDIX B

Conversions:
International System of Units to English Units

MULTIPLY	BY	TO GET
Length:		
centimeters (cm)	0.3937	inches (in)
meters (m)	3.281	feet (ft)
kilometers (km)	0.621	miles (mi)
Area:		
square meters (m^2)	10.76	square feet (ft^2)
square kilometers (km^2)	0.3861	square miles (mi^2)
square kilometers (km^2)	247.1	acres (ac)
Volume:		
liters (L)	0.264	gallons (gal)
cubic meters (m^3)	264.17	gallons (gal)
cubic meters (m^3)	0.00081	acre-feet (a-f)
Flow:		
liters per second (L/s)	0.0353	cubic feet per second (cfs)
liters per second (L/s)	15.85	gallons per minute (gpm)
cubic meters per second (m^3/s)	35.31	cubic feet per minute (cfm)
cubic meters per second (m^3/s)	0.000158	gallons per minute (gpm)
cubic meters per second (m^3/s)	70.05	acre-feet per day (a-f/d)
Temperature:		
degrees Celsius	multiply by 1.8 then add 32	degrees Fahrenheit

APPENDIX C

Cave Map Symbols

APPENDIX L

Grazing Management Plan (GMP)

Preparer's Note: The GMP will be included upon its completion.

PRESCRIPTIONS

1.0 Introduction

The objective of this section is to present the natural resources management activities that will be implemented in each management unit as a result of this INRMP. Section 2.0 identifies the projects considered to be of the highest priority and most likely to be funded. Section 3.0 illustrates the management units (MUs) and provides a summary of the physical characteristics of each one. Section 4.0 presents the management goals and priorities for each MU. Section 5.0 lists the projects that are to be implemented in each MU to ensure that Fort Hood achieves its natural resource management goals and ultimately obtains the Desired Future Conditions described in Section 3.2 of the INRMP.

2.0 Project Priority

The Office of the Secretary of Defense considers funding for the preparation and implementation of this INRMP, as required by the Sikes Act, a high priority. The reality, however, is that not all of the projects and programs identified in this INRMP will receive immediate funding. Consequently, the programs and projects have been screened and only the high-priority projects are included in this section. The prioritization of the projects is based on need, and need is based on a project's importance in moving the natural resources management program closer to successfully achieving its goal. Projects will be conducted subject to the availability of funding.

The high-priority projects identified by the NRMB, in alphabetical order, are as follows:

- Brown-headed cowbird control
- Cave monitoring
- Cave survey, mapping, and inventory
- Caves and cave fauna
- Construct off-site wetland mitigation bank
- Construction and maintenance of fire breaks
- Ecosystem plantings
- Erosion control and revegetation of watersheds
- Fire damage abatement projects
- Fisheries management
- Habitat delineation
- Implementation of karst management plan
- Juniper management
- Lake and pond management

- Oak wilt management in endangered species habitat
- Planning Level Surveys
- Predator control
- Predator population management
- Prescribed burning for ecosystem management
- Protection of T&E species: golden-cheeked warblers
- Protection of T&E species: black-capped vireos
- Repair of eroded and damaged trails
- Stream water sampling stations and mitigation
- Survey of endemic cave salamander
- Survey of Texas horned lizard
- Training lands management plan
- Vegetation monitoring of fire effects in endangered species habitat
- Wetland survey
- Wildlife management

3.0 Management Units

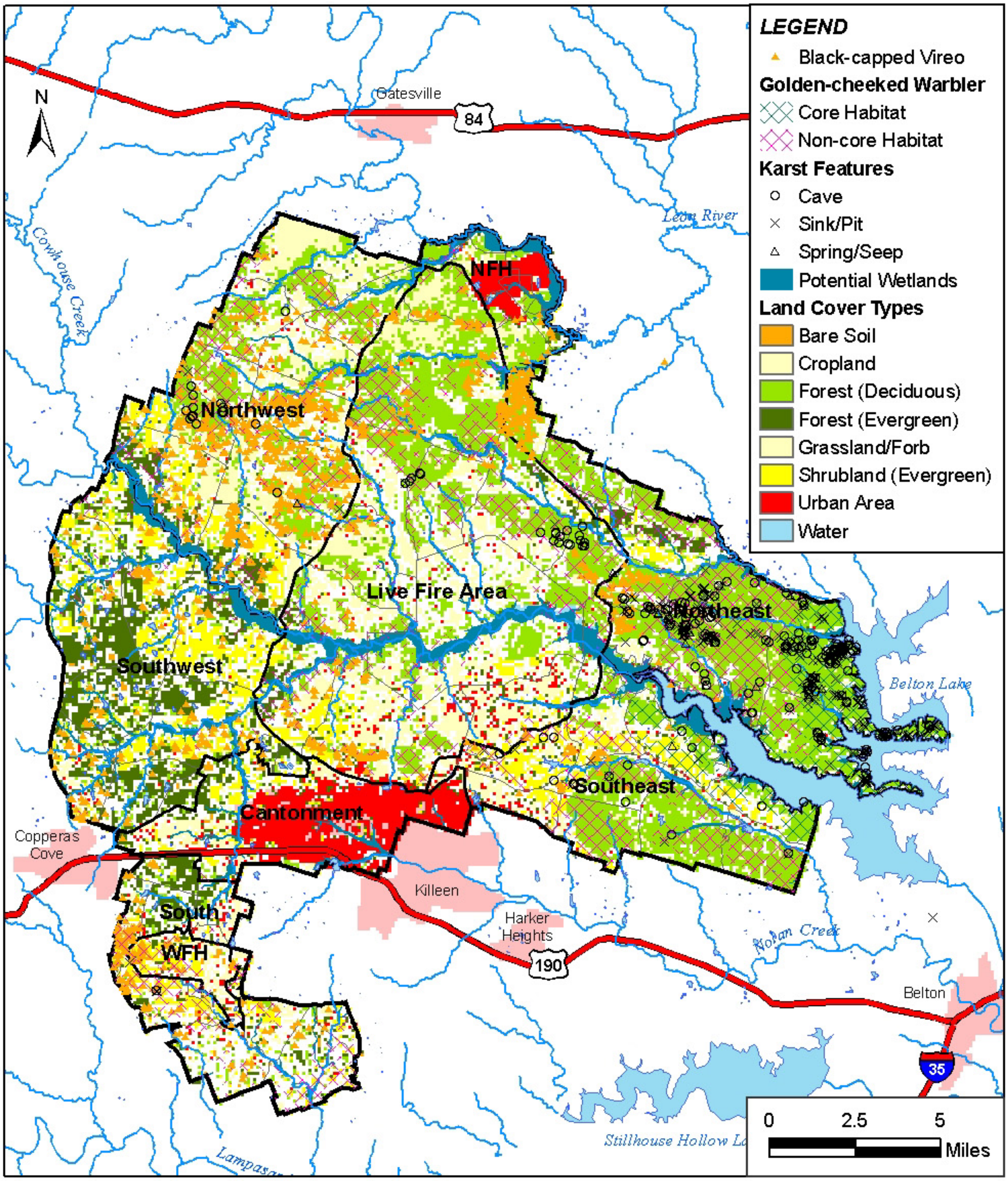
For ease of allocating resources (staff and funding), Fort Hood's NRMB has divided the installation into functional MUs, which are similar to the grazing MUs. Figure P-1 shows the MUs, and the physical characteristics of each MU are summarized in Table P-1.

4.0 Management Unit Goals and Priorities

4.1 Live Fire Area

The live-fire and impact areas do not host much maneuver training and traffic and are limited primarily to vehicles moving to and from the ranges. Access to the impact area is restricted because of danger from direct fire and indirect fire from active ranges and unexploded ordnance.

Goal for Live-Fire Area. Support the military mission, protect endangered species and karst habitats, and maintain ecosystem integrity.



LEGEND

Installation Boundary

Region Boundary

Training Area Boundary

Source: Fort Hood GIS, 2005; USGS, 2003.

Management Units

Figure P-1

Table P-1

Physical Characteristics of Management Units

	Land Cover				Streams	Water Bodies		Core Habitat		Non-Core Habitat	
Region	**Bare Ground**		**Vegetation**		**Stream Miles**	**Acres**	**Percent Area**	**Acres**	**Percent Area**	**Acres**	**Percent Area**
	Acres	**Percent**	**Acres**	**Percent**							
Live-Fire Area	597	1.0	58,893	96.0	252.0	11.4	0.02	0.0	0.0	13,314.8	21.7
North Fort Hood	147	2.5	3,638	62.2	21.0	50.9	0.87	0.0	0.0	233.1	4.0
Northeast	30	0.1	25,592	90.6	78.5	15.5	0.05	6,617.7	23.4	18,103.2	64.1
Northwest	1,112	3.1	34,430	96.2	153.6	69.7	0.19	0.0	0.0	7,387.9	20.6
South	4	0.0	14,045	89.6	65.9	44.8	0.29	0.0	0.0	3,578.0	22.8
Southeast	93	0.4	21,853	93.0	67.9	159.3	0.68	2,944.3	12.5	10,129.0	43.1
Southwest	1,584	5.1	29,371	94.0	177.2	340.4	1.09	0.0	0.0	990.3	3.2
INSTALLATION	**3,567**		**187,822**		**816.1**	**692**		**9,562**		**53,736.3**	

Management Priorities. This MU has the second-largest acreage of non-core endangered species habitat of any MU on the installation. There are approximately 13,315 acres of habitat, which constitutes more than 21 percent of the MU. In addition, the MU has 252 miles of streams, including Cowhouse Creek, which empties into Belton Lake, the drinking water supply for Fort Hood and surrounding municipalities. It is necessary to maintain water quality monitoring in Cowhouse Creek as it exits the live-fire area to ensure that the water does not transport contaminants to Belton Lake. Because very little maneuvering of mechanized vehicles occurs in this area, the MU is not subjected to the same degradation as other areas, such as the Northwest and Southwest MUs in the Western Maneuver Area. Although the restricted nature of the area precludes access to a significant portion of the MU, most of the high-priority management activities will be implemented to the extent practical.

4.2 South

The South management unit includes West Fort Hood and Land Group 7. West Fort Hood consists of Robert Gray Army Airfield, the Ammunition Supply Point, research and administrative facilities for the Operation Testing Command (OTC), support facilities, and housing for military personnel, which accommodates both families and unaccompanied troops. The South MU is used primarily for small mechanized units and dismounted infantry training and for logistical sites. It is too small and isolated to be used for maneuver training.

Goal for South Fort Hood. Support the military mission, maintain ecosystem integrity, and protect endangered species habitat.

Management Priorities. The low-impact training that occurs in this MU results in minimal degradation of the resources in the training area. Nearly 23 percent of the MU is composed of non-core endangered species habitat, making habitat management a key activity in this location.

4.3 Southwest

The Southwest MU constitutes the southern portion of the Western Maneuver Area. Training in this MU consists of battalion- and brigade-level training (up to 3,000 vehicles—800 tracked and 2,200 wheeled), which is conducted year-round for approximately 21 days per month. Of all the MUs on the installation, the Southwest MU has the greatest percentage of area receiving significant training disturbance (60 to 79 percent). Given the level of training and associated disturbance, it is not surprising that the Southwest MU also has the highest number of acres and percentage of bare ground of any management unit.

Goals for Southwest. Support the military mission, increase vegetative cover, minimize erosion and sedimentation, and improve the sustainability of the training area.

Management Priorities. Because over 5 percent of the MU consists of bare ground, management activities must focus on stabilizing the soils, increasing the vegetative cover, minimizing erosion, and improving the sustainability of the training area. The Southwest MU also contains 177 miles of streams and therefore the aquatic habitat, fisheries, and water quality will continue to be at risk from sedimentation until the sediments are stabilized. The endangered species habitat in this MU is non-core habitat and relatively minimal in comparison to other MUs (2 percent of total acreage).

4.4 Northwest

The Northwest MU constitutes the northern portion of Fort Hood's Western Maneuver Area, and training in this area is similar to the training that occurs in the Southwest MU. The Northwest MU has the most extensive gully network of all the MUs on the installation. Sediment from severe erosion flows into the various streams of the Cowhouse Creek watershed and eventually settle into Belton Lake.

Goal for the Northwest. Support the military mission, increase vegetative cover, minimize erosion and sedimentation, protect endangered species habitat, and improve the sustainability of the training area.

Management Priorities. With 1,112 acres of bare ground, this MU ranks second only to the Southwest MU. The severe degradation of the vegetative cover has resulted in an extensive gully network that requires significant resources for repair, as well as to prevent further erosion and sediment loading to the streams. A primary focus for this MU is to revegetate the bare areas and to increase the density of the vegetative cover throughout the MU.

In addition, approximately 20 percent of the Northwest MU consists of non-core endangered species habitat. In fact, this MU contains the largest population of nesting black-capped vireos of all the MUs on the installation. Management activities will focus on maintaining the ecological integrity of the habitat to ensure that Fort Hood continues to achieve its regional recovery goals for golden-cheeked warblers and black-capped vireos.

4.5 North Fort Hood

Activities at North Fort Hood occur primarily during summer training and are similar to those of the main cantonment area. Nearly a third of the management unit is cantonment area; the remaining area consists of deciduous forest and woodlands. The Leon River forms the northern border, and there are potential jurisdictional wetlands along the floodplain.

Goals for North Fort Hood. Support the military mission and maintain the ecological integrity of the area surrounding the cantonment area.

Management Priorities. The North Fort Hood MU receives relatively little disturbance from training and therefore degradation is minimal. Endangered species habitat is found in this area, but it is non-core habitat and represents less than 1 percent of the total non-core endangered species habitat on the installation. The primary focus for management on this MU is to maintain the ecological integrity.

4.6 Northeast

The Northeast MU is heavily vegetated and cross-compartmentalized by terrain features, providing limited value as a mechanized maneuver area. The area is used year-round primarily for wheeled and tracked vehicle maneuvering and for dismounted military police training. The Northeast MU contains a significant amount of core and non-core endangered species habitat. It has restrictive terrain and vegetation, and therefore training is normally conducted on the roads and trails.

Goals for the Northeast. Support the military mission, protect endangered species and karst habitat, and maintain ecosystem integrity.

Management Priorities. Core endangered species habitat is found in two of the MUs on Fort Hood. The Northeast MU contains approximately 70 percent of the core and 34 percent of non-core endangered species habitat, and most of this area is golden-cheeked warbler habitat. In fact, 23 percent of the Northeast MU is core habitat. Because this area contains core habitat, training restrictions and constraints are enforced in this area during the nesting season. In addition, this MU has the highest known concentration of karst habitat and features compared to any other MU on Fort Hood. Significant effort and use of resources can be expected to be expended to protect these sensitive habitats and the species inhabiting them. In addition, this area will continue to be surveyed for additional caves and the endemic karst/cavernicole species inhabiting them. It is important for Fort Hood to ensure the protection of these areas to minimize the potential for the future listing of the karst species, which would likely result in additional restrictions on training.

A significant portion of this MU is bordered by water, including Belton Lake. As a result, it is important to maintain vegetated watersheds and riparian buffers to protect water quality, aquatic habitat, and biological communities, including fisheries. This is the only MU in which all programmed high-priority projects are scheduled for implementation.

4.7 Southeast

The southeast MU is used year-round for some tracked-vehicle maneuver and dismounted training, and it contains most of the installation's artillery firing points for 155mm cannon and Multiple Launch Rocket System rockets. This MU is heavily vegetated and contains a significant amount of both core and non-core endangered species habitat, the majority of which is golden-cheeked warbler habitat. The northern border consists of Cowhouse Creek and Belton Lake. The BLORA, Fort Hood's premiere outdoor recreation area, is in this MU.

***Goals for Southeast*.** Support the military mission, protect endangered species and karst habitat, and maintain ecosystem integrity.

Management Priorities. More than 12 percent of the Southeast MU is core habitat and 43 percent is non-core habitat. The majority of this habitat is golden-cheeked warbler habitat. As with the Northeast MU, the presence of core habitat results in seasonal training restrictions to protect golden-cheeked warblers and black-capped vireos during the nesting season. The Southeast MU contains some karst habitat, which must be monitored and protected. Surveys for additional caves and species will continue to be conducted in this area.

Cowhouse Creek and Belton Lake compose the northern border of this MU. As with the Northeast MU, it is important to maintain vegetated watersheds and riparian buffers to protect water quality, aquatic habitat, and biological communities, including fisheries.

5.0 Project Summary for Management Units

As noted in Section 2.0, the Fort Hood NRMB has identified a list of projects that are of high priority and must be implemented to ensure that the natural resources management program achieves its goal of maintaining the long-term sustainability of the training lands. Table P-2 indicates which projects are expected to be implemented or to continue to be implemented in each MU.

Table P-2

Summary of Projects for Each Management Unit

Project	Management Unit						
	Live-Fire Area	North Ft. Hood	Northeast	Northwest	South	Southeast	Southwest
Brown-headed cowbird control	•	•	•	•	•	•	•
Cave monitoring	•		•	•	•	•	
Cave survey, mapping and inventory	•		•	•	•	•	
Caves and cave fauna	•		•	•	•	•	
Construction and maintenance of fire breaks	•	•	•	•	•	•	•
Ecosystem plantings	•	•	•	•	•	•	•
Erosion control and revegetation of watersheds	•	•	•	•	•	•	•
Fire damage abatement projects	•	•	•			•	
Fisheries management	•	•	•	•	•	•	•
Habitat delineation	•	•	•	•	•	•	•
Implementation of karst management plan	•		•	•	•	•	
Juniper management	•	•	•	•	•	•	•
Lake and pond management	•	•	•	•	•	•	•
Oak wilt management in endangered species habitat	•	•	•	•	•	•	•
Planning Level Surveys	•	•	•	•	•	•	•
Predator control	•	•	•	•	•	•	•
Predator population management	•	•	•	•	•	•	•
Prescribed burning for ecosystem management	•	•	•	•	•	•	•
Protection of T&E species: golden-cheeked warblers	•	•	•	•	•	•	•

Table P-2

Summary of Projects for Each Management Unit

Project	Management Unit						
	Live-Fire Area	North Ft. Hood	Northeast	Northwest	South	Southeast	Southwest
Protection of T&E species: black-capped vireo	•	•	•	•	•	•	•
Repair of eroded and damaged trails	•	•	•	•	•	•	•
Stream water sampling stations and mitigation	•		•	•	•	•	
Survey of endemic cave salamander	•		•	•	•	•	
Survey of Texas horned lizard	•	•	•	•	•	•	•
Training lands management plan	•	•	•	•	•	•	•
Vegetation monitoring of fire effects in endangered species habitat	•		•				
Wetland survey	•	•	•	•	•	•	•
Wildlife management	•	•	•	•	•	•	•

ACRONYMS and ABBREVIATIONS

AACC	Area Access Control Center
ACUB	Army Compatible Use Buffer
AIA	Artillery Impact Area
AR	Army Regulation
ARTEP	Army Training and Readiness Evaluation Program
ASP	Ammunition Supply Point
ATTACC	Army Training and Testing Area Carrying Capacity
AU	animal unit
BCT	brigade combat team
BLORA	Belton Lake Outdoor Recreation Area
BMP	best management practice
BO	Biological Opinion
BOD	biological oxygen demand
BRAC	Base Realignment and Closure
BREC	Blackland Research and Extension Center
CERL	U.S. Army Corps of Engineers Environmental Research Laboratory
CEQ	Council for Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CG	Commanding General
CHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
COD	chemical oxygen demand
CTCA	Central Texas Cattlemen’s Association
CWA	Clean Water Act
DA	Department of the Army
DCA	Directorate of Community Activities
DFC	Desired Future Condition
DO	dissolved oxygen
DoD	Department of Defense
DOI	U.S. Department of the Interior
DPTS	Directorate of Plans, Training, and Security
DPW	Directorate of Public Works
EA	environmental assessment
ECOC	Equipment Checkout Center
EE	eligible entity
EIS	environmental impact statement
EMD	Environmental Management Division
EO	Executive Order
EPR	Environmental Program Requirements
ESA	Endangered Species Act
ESMP	Endangered Species Management Plan
FARP	forward area refueling point
FH	Fort Hood
FM	frequency modulated
FNSI	Finding of No Significant Impact
FY	fiscal year
GIS	geographic information system
GMP	Grazing Management Plan
GMU	Grazing Management Unit
GPM	gallons per minute
GPS	global positioning system
HAAF	Hood Army Airfield
HQDA	Headquarters, Department of the Army
IAP	Installation Action Plan
ICRMP	Integrated Cultural Resource Management Plan
INRMP	Integrated Natural Resources Management Plan
IPM	integrated pest management
IPMP	Integrated Pest Management Plan
IRP	Installation Restoration Program
ITAM	Integrated Training Area Management
ITLM	Integrated Training Land Management
LCTA	Land Condition Trend Analysis
LF	Live-Fire Areas
LRAM	Land Rehabilitation and Maintenance
LSMP	Land Sustainment Management Plan
LUR	Land Use Regulations
MACOM	Major Command
MCL	maximum contaminant level
MDP	Maneuver Damage Program
MDRT	Maneuver Damage Repair Teams
MLRS	Multiple Launch Rocket Systems
MOU	Memorandum of Understanding
MTOE	Mobilization Table of Organization and Equipment
MU	management unit
MWR	Morale Welfare and Recreation
NCA	Natural and Cultural Area
NEPA	National Environmental Policy Act
NFA	No Further Action
NFH	North Fort Hood
NMFS	National Marine Fisheries Service
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places

NRMB	Natural Resources Management Branch
OTC	Operational Test Command
OUSD	Office of the Undersecretary of Defense
PD	Permanent Dudded Area
PLS	Planning Level Survey
PMO	Provost Marshal Office
POV	privately owned vehicle
RCRA	Resource Conservation and Recovery Act
REPI	Readiness and Environmental Protection Initiative
RGAAF	Robert Gray Army Airfield
RSTA	reconnaissance, surveillance, and target acquisition
RTLA	Range and Training Land Analysis
RUSLE	Revised Universal Soil Loss Equation
SAIA	Sikes Act Improvement Act
SARA	Superfund Amendments and Reauthorization Act
SEA	supplemental environmental assessment
SOP	Standard Operating Procedure
SRA	Sustainable Range Awareness
SWMP	storm water management program
SWMU	solid waste management unit
TAMUS	Texas A&M University System
TCEQ	Texas Commission on Environmental Quality
TCP	Traditional Cultural Properties
TES	threatened and endangered species
TMDL	Total Maximum Daily Load
TNC	The Nature Conservancy
TPDES	Texas Pollutant Discharge Elimination System
TPWD	Texas Parks and Wildlife Department
TRI	Training Requirements Integration
TSCA	Toxic Substances Control Act
TSS	total suspended solids
UA	unit of action
UCL	upper confidence level
UEx	division-level unit of employment
UEy	Corps-level unit of employment
USACE	U.S. Army Corps of Engineers
USAEC	U.S. Army Environmental Center
USEPA	U.S. Environmental Protection Agency
U.S.C.	United States Code
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USLE	Universal Soil Loss Equation
WFH	West Fort Hood
WFHTC	West Fort Hood Travel Camp
WWTP	wastewater treatment plant